



genomics@genomics: ~



genomics@genomics:~\$

Introduction to Linux

Farzaneh Salari

NGS WORKSHOP

1403/06/27

Slides based on Sophie Shaw's Slides

Learning Objectives

1. Installing Ubuntu Virtual Machine
2. Training File and Directory Commands (Terminal)
3. Training Viewing and Searching File Commands (Terminal)
4. Installing software packages on Ubuntu OS

Watching vs Doing



Listen when you see this cat

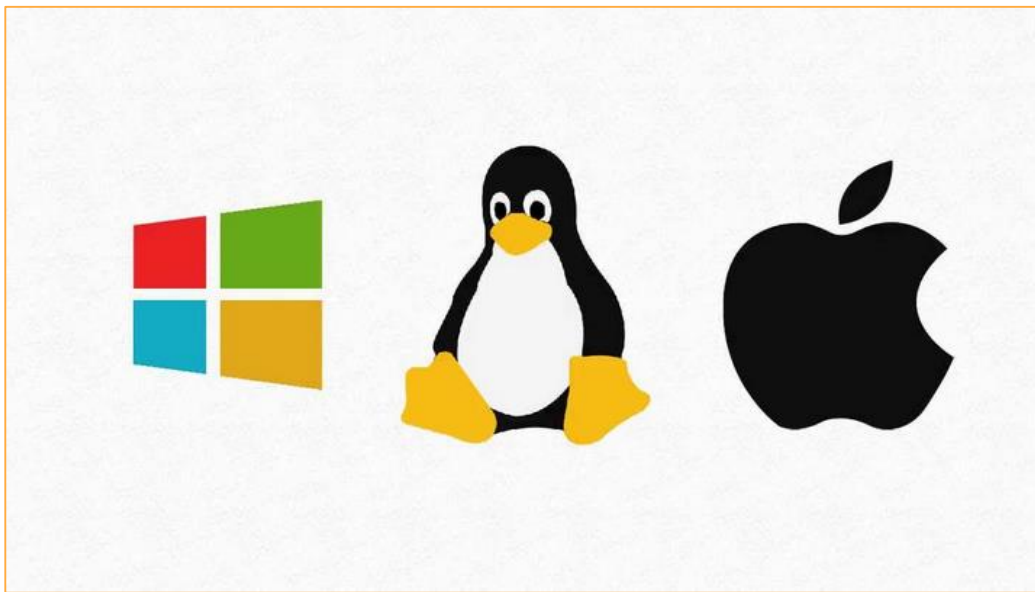


Do when you see this cat



What is Linux?

- Operating System



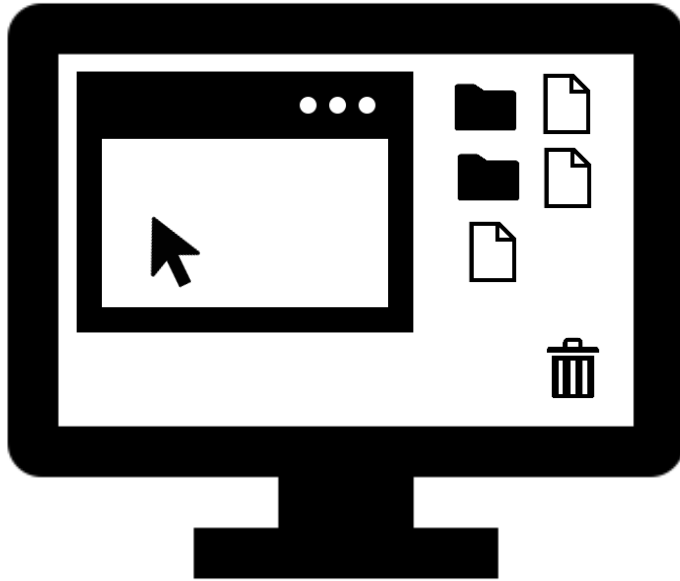
Why Linux?



- Bioinformatics software designed to run on Linux platforms.
- Large amounts of data.
- Much faster than your Windows PC.



Command line interface



Graphical User Interface (GUI)



Command Line Interface (CLI)

```
beta@test-i5:~/samples$ █
```



Username

Host

Working
directory

Prompt

Type your
commands here!

We use these names

genomics@genomics:~\$ █

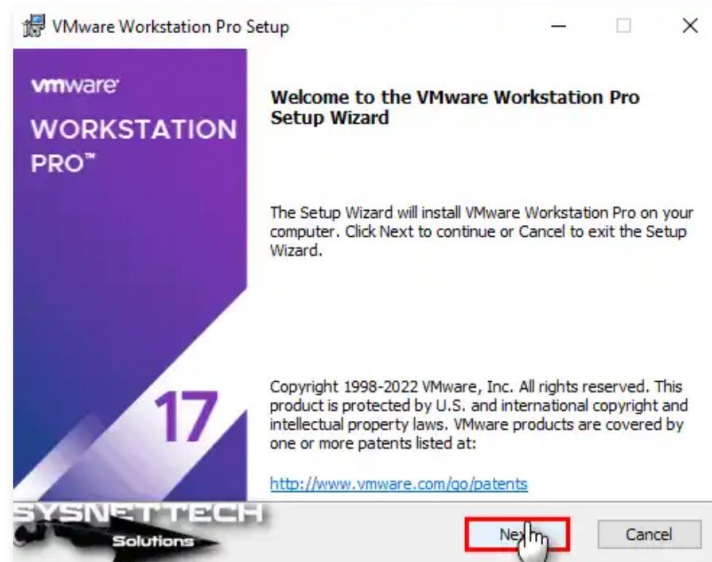
Username

Host

Installing Ubuntu Virtual Machine

1. Downloading VMware workstation pro 17 and Ubuntu 22
 1. <https://soft98.ir/os/virtual-machine/1232-vmware-workstation.html>
 2. <https://releases.ubuntu.com/22.04/ubuntu-22.04.5-desktop-amd64.iso>
2. Installing VMware
3. Installing Ubuntu on VMware

Install VMware workstation pro 17



End-User License Agreement

Please read the following license agreement carefully.

VMWARE END USER LICENSE AGREEMENT

Last updated: 03 May 2021

THE TERMS OF THIS END USER LICENSE AGREEMENT ("EULA") GOVERN YOUR USE OF THE SOFTWARE, REGARDLESS OF ANY TERMS THAT MAY APPEAR DURING THE INSTALLATION OF THE SOFTWARE.

☒ I accept the terms in the License Agreement

Print

Back

Next

Cancel

Custom Setup

Select the installation destination and any additional features.

Install to:
C:\Program Files (x86)\VMware\VMware Workstation\

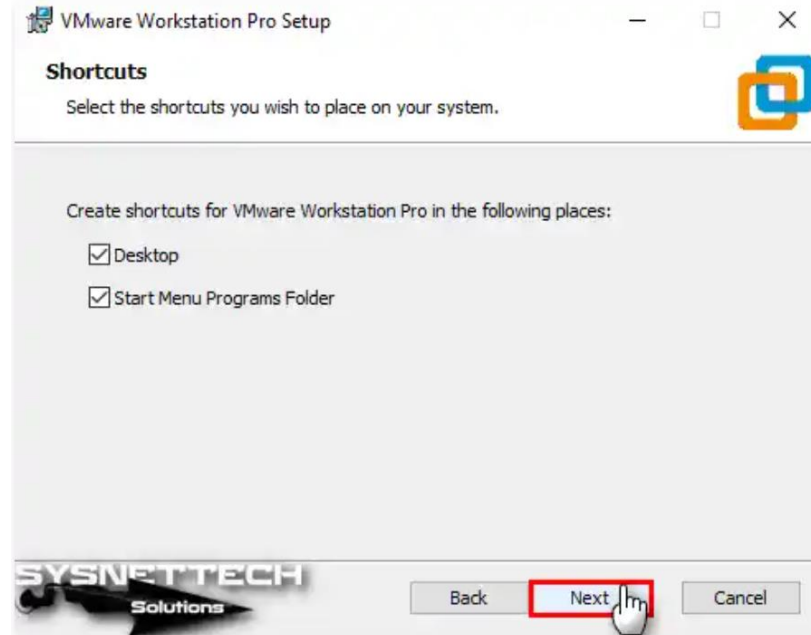
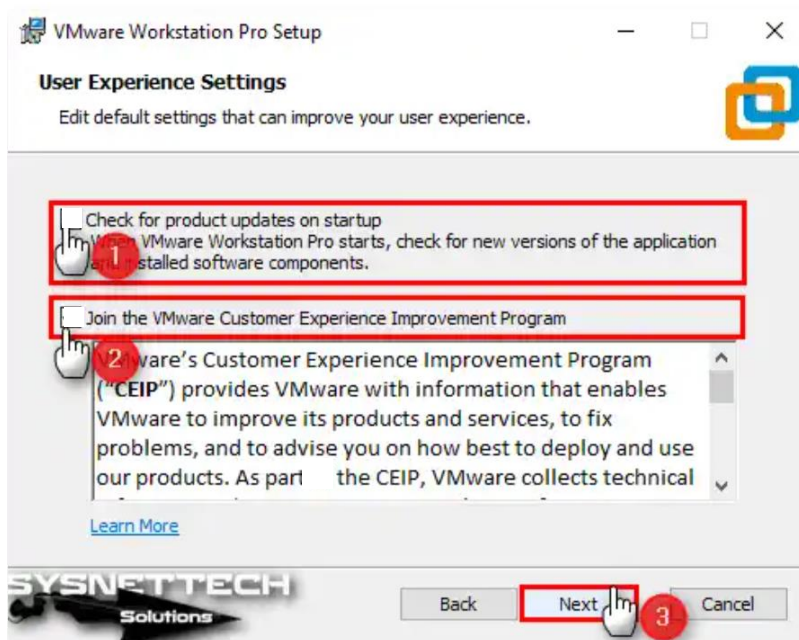
Change...

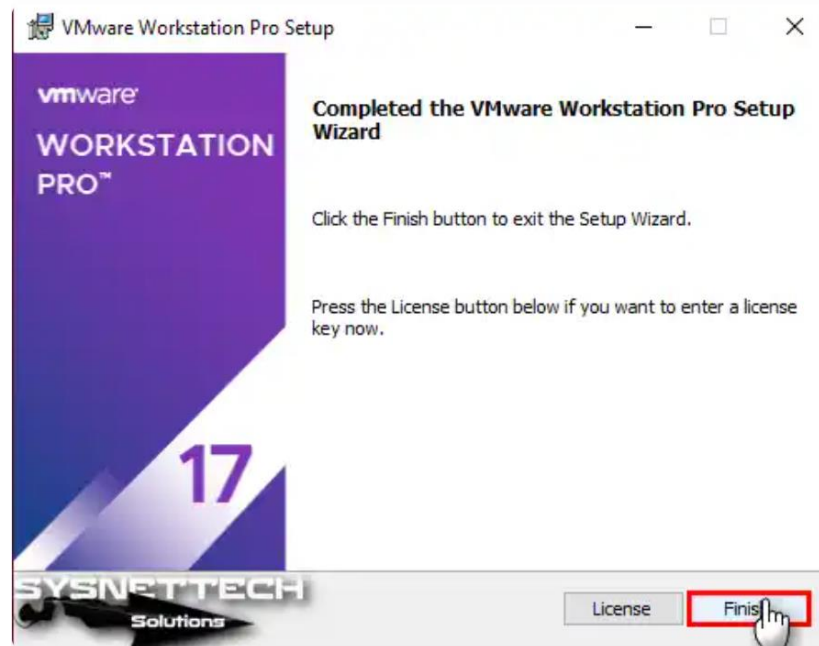
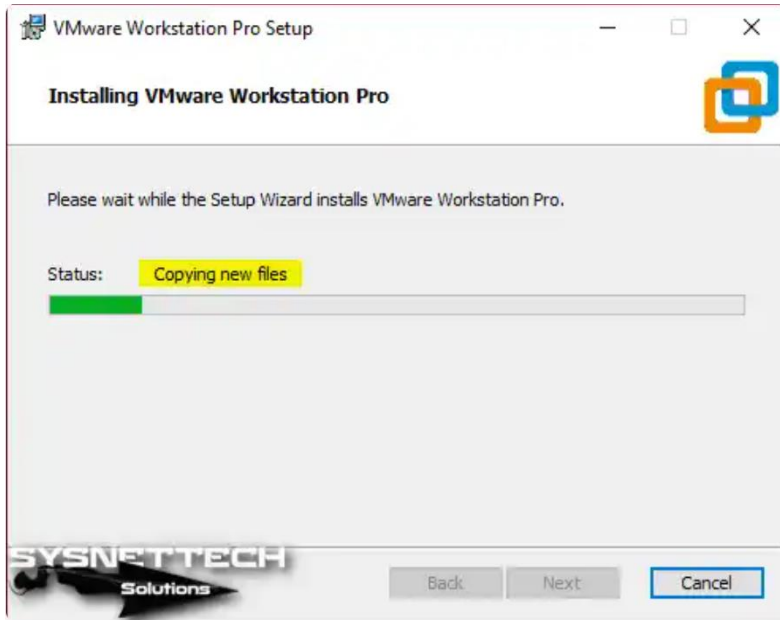
☒ Add VMware Workstation console tools into system PATH

Back

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Cancel



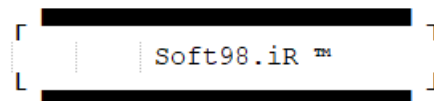
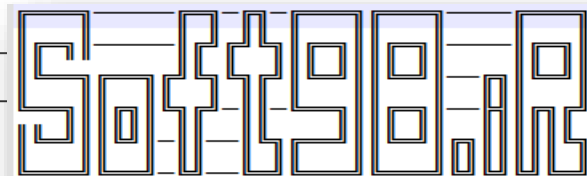
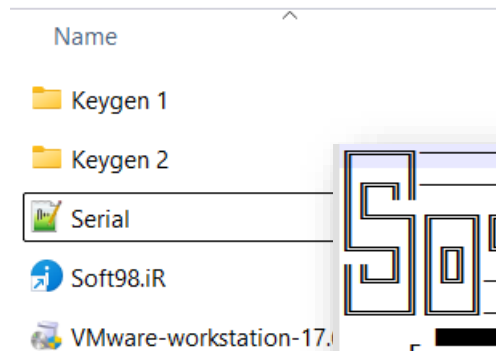




When the PC restarts,
double-click the VMware shortcut to open it.



SYSNETTECH
Solutions



JC480-0E101-MJ4Y8-11AEM-86868
4V6H0-AX305-4J8T8-0TCG4-96KP6
MC60H-DWHD5-H80U9-6V85M-8280D
MY2E8-AJJ4Q-MJ0W8-00CQ4-87R02
0V6DH-6U04M-HJD08-02852-AK0HF

Create a New Virtual Machine



Library

X

Home My Computer vm-install-test Ubuntu-22 64-bit

Type here to search

My Computer

- Ubuntu-22 64-bit
- vm-install-test

WORKSTATION PRO™ 17



Create a New
Virtual Machine



Open a Virtual
Machine



Connect to a
Remote Server



Library

x



Home x



My Computer x



vm-install-test x



Ubuntu-22 64-bit x

Type here to search

- My Computer
 - Ubuntu-22 64-bit
 - vm-install-test

New Virtual Machine Wizard

x

vmware
WORKSTATION
PRO™

17

Welcome to the New Virtual Machine Wizard

What type of configuration do you want?

- ☒ Typical (recommended)
Create a Workstation 17.x virtual machine in a few easy steps.
- ☐ Custom (advanced)
Create a virtual machine with advanced options, such as a SCSI controller type, virtual disk type and compatibility with older VMware products.

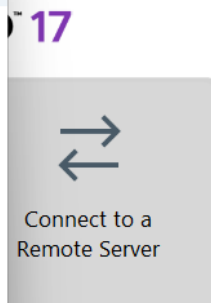
Help

< Back

Next >

Cancel

vmware





Library

Type here to search

My Computer

- Ubuntu-22 64-bit
- vm-install-test

Home My Computer vm-install-test Ubuntu-22 64-bit

New Virtual Machine Wizard

Guest Operating System Installation

A virtual machine is like a physical computer; it needs an operating system. How will you install the guest operating system?

Install from:

☐ Installer disc:

BD-ROM Drive (E:)

☒ Installer disc image file (iso):

D:\4-Software\Ubuntu\ubuntu-22.04.3-desktop-amd64

Browse...

☐ Ubuntu 64-bit 22.04.3 detected.This operating system will use Easy Install. [\(What's this?\)](#)☐ I will install the operating system later.

The virtual machine will be created with a blank hard disk.

Help

< Back

Next >

Cancel



Library

X

Type here to search

- My Computer
 - Ubuntu-22 64-bit
 - vm-install-test

Home x My Computer x vm-install-test x Ubuntu-22 64-bit x

New Virtual Machine Wizard

X

Easy Install Information

This is used to install Ubuntu 64-bit.

Personalize Linux

Full name: Farzaneh Salari

User name: farzsalari

Password: •••••

(optional)

Confirm: •••••

Help

< Back

Next >

Cancel

17

Connect to a
Remote Server



Library

x



Home x



My Computer x



vm-install-test x



Ubuntu-22 64-bit x

Type here to search

- My Computer
 - Ubuntu-22 64-bit
 - vm-install-test

New Virtual Machine Wizard



Name the Virtual Machine

What name would you like to use for this virtual machine?

Virtual machine name:

Ubuntu 64-bit

Location:

C:\Users\farzsalari\Documents\Virtual Machines\Ubuntu 64-bit

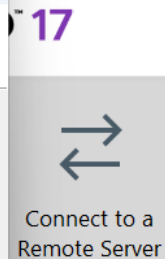
Browse...

The default location can be changed at Edit > Preferences.

< Back

Next >

Cancel





Library

Type here to search

- My Computer
 - Ubuntu-22 64-bit
 - vm-install-test

Home My Computer vm-install-test Ubuntu-22 64-bit

New Virtual Machine Wizard

Specify Disk Capacity

How large do you want this disk to be?

The virtual machine's hard disk is stored as one or more files on the host computer's physical disk. These file(s) start small and become larger as you add applications, files, and data to your virtual machine.

Maximum disk size (GB):

Recommended size for Ubuntu 64-bit: 20 GB

- ☐ Store virtual disk as a single file
- ☒ Split virtual disk into multiple files

Splitting the disk makes it easier to move the virtual machine to another computer but may reduce performance with very large disks.

Help

< Back

Next >

Cancel

17

Connect to a Remote Server



Library

Type here to search

- My Computer
 - Ubuntu-22 64-bit
 - vm-install-test

Home My Computer vm-install-test Ubuntu-22 64-bit

New Virtual Machine Wizard

Ready to Create Virtual Machine

Click Finish to create the virtual machine and start installing Ubuntu 64-bit and then VMware Tools.

The virtual machine will be created with the following settings:

Name:	Last-install-test
Location:	C:\Users\farzsalari\Documents\Virtual Machines\Last-in...
Version:	Workstation 17.x
Operating System:	Ubuntu 64-bit
Hard Disk:	20 GB, Split
Memory:	4096 MB
Network Adapter:	NAT
Other Devices:	2 CPU cores, CD/DVD, USB Controller, Printer, Sound C...

[Customize Hardware...](#)

☒ Power on this virtual machine after creation

< Back

Finish

Cancel

17

Connect to a Remote Server

VMware Workstation

File Edit View VM Tabs Help

Library X

Type here to search

My Computer

- Ubuntu-22 64-bit
- vm-install-test

Device	Summary
Memory	4 GB
Processors	2
New CD/DVD (SATA)	Using file D:\4-Software\Ubu...
Network Adapter	NAT
USB Controller	Present
Sound Card	Auto detect
Printer	Present
Display	Auto detect

Add...

Remove

Memory

Specify the amount of memory allocated to this virtual machine. The memory size must be a multiple of 4 MB.

Memory for this virtual machine: 8192 MB

128 GB
64 GB
32 GB
16 GB
8 GB
4 GB
2 GB
1 GB
512 MB
256 MB
128 MB
64 MB
32 MB
16 MB
8 MB
4 MB

- Maximum recommended memory
(Memory swapping may occur beyond this size.)
13.2 GB
- Recommended memory
4 GB
- Guest OS recommended minimum
2 GB

Close

Help

Install Ubuntu 22

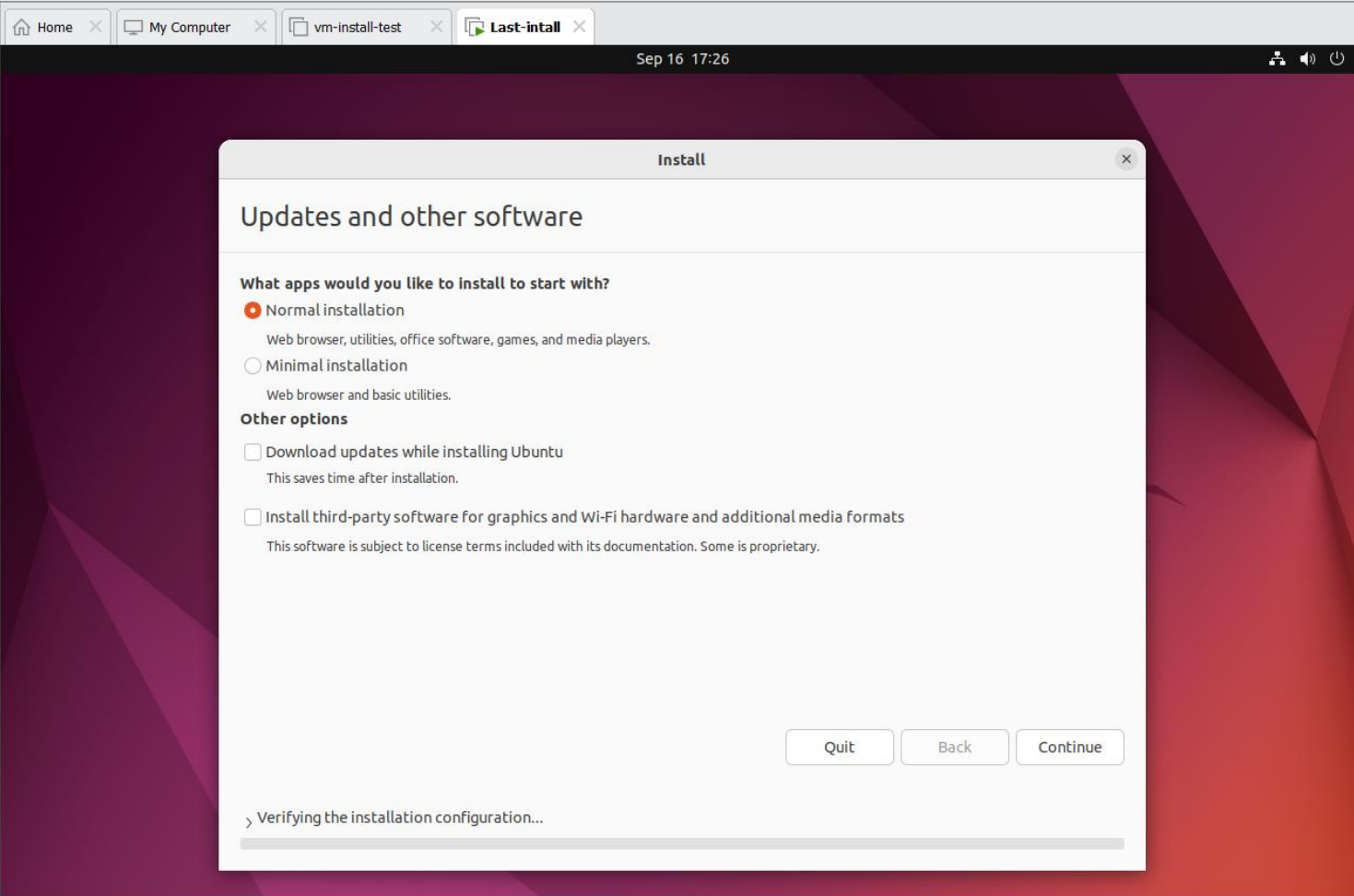


Click in the virtual screen to send keystrokes

Easy Install is installing Ubuntu 64-bit. Internet connection is required for Ubuntu14.04 and higher version to install open-vm-tools.

Help

Keyboard layout



Click in the virtual screen to send keystrokes

Easy Install is installing Ubuntu 64-bit. Internet connection is required for Ubuntu14.04 and higher version to install open-vm-tools.

Help

k inside or press Ctrl+G.



Install

Installation type

This computer currently has no detected operating systems. What would you like to do?

☒ Erase disk and install Ubuntu
Warning: This will delete all your programs, documents, photos, music, and any other files in all operating systems.

Advanced Features... None selected

☐ Something else
You can create or resize partitions yourself, or choose multiple partitions for Ubuntu.

Quit

Back

Install Now

> Verifying the installation configuration...

Installation type

This computer currently has no detected operating systems. What would you like to do?

- Erase disk and install Ubuntu

Warning: This will delete all your programs, documents, photos, music, and any other files in all operating systems.

Advanced features... None selected

Write the changes to disks?

If you continue, the changes listed below will be written to the disks. Otherwise, you will be able to make further changes manually.

The partition tables of the following devices are changed:
SCSI11 (0,0,0) (sda)

The following partitions are going to be formatted:
partition #2 of SCSI11 (0,0,0) (sda) as ESP
partition #3 of SCSI11 (0,0,0) (sda) as ext4

[Go Back](#)

Continue

[Back](#)

Install Now

› Verifying the installation configuration...

Install



Continue

```
> Creating ext4 file system for / in partition #3 of SCSI11 (0,0,0) (sda)...
```


Who are you?

Your name: Farzaneh ✓

Your computer's name: genomics ✓

The name it uses when it talks to other computers.

Pick a username: genomics ✓

Choose a password: ●●●●●●



Fair password

Confirm your password: ●●●●●● ✓

☐ Log in automatically

☒ Require my password to log in

☐ Use Active Directory

You'll enter domain and other details in the next step.

Back

Continue

> Copying files...



Install

Welcome to Ubuntu

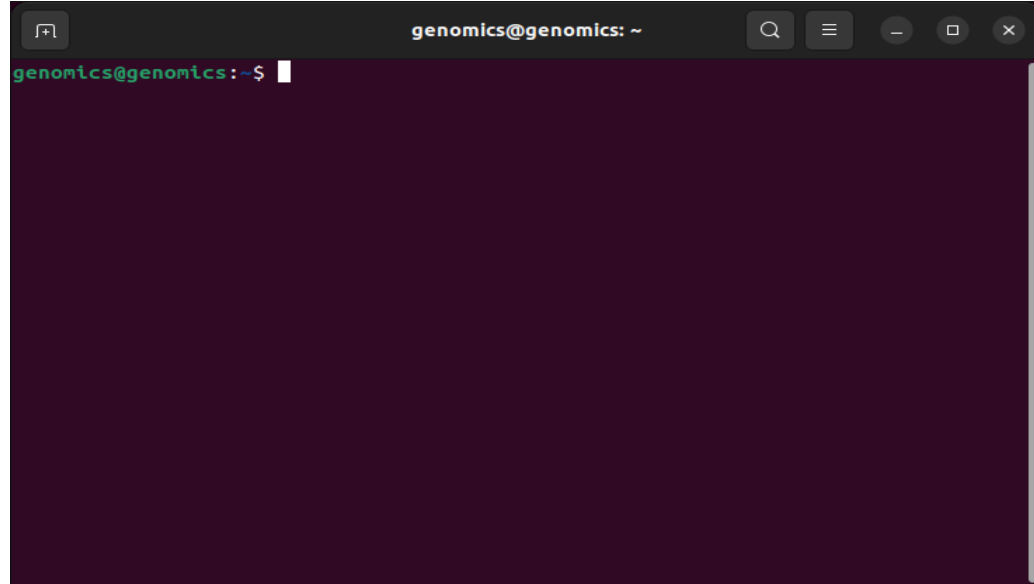
Fast and full of new features, the latest version of Ubuntu makes computing easier than ever. Here are just a few cool new things to look out for...



> Copying files...



The Terminal



The Command Line, The Shell, The Prompt

Where you see this “\$” followed by text, I want you to type the text on your command line

File Commands	System Info
<p>ls - directory listing</p> <p>ls -al - formatted listing with hidden files</p> <p>cd <i>dir</i> - change directory to <i>dir</i></p> <p>cd - change to home</p> <p>pwd - show current directory</p> <p>mkdir <i>dir</i> - create a directory <i>dir</i></p> <p>rm <i>file</i> - delete <i>file</i></p> <p>rm -r <i>dir</i> - delete directory <i>dir</i></p> <p>rm -f <i>file</i> - force remove <i>file</i></p> <p>rm -rf <i>dir</i> - force remove directory <i>dir</i> *</p> <p>cp <i>file1 file2</i> - copy <i>file1</i> to <i>file2</i></p> <p>cp -r <i>dir1 dir2</i> - copy <i>dir1</i> to <i>dir2</i>; create <i>dir2</i> if it doesn't exist</p> <p>mv <i>file1 file2</i> - rename or move <i>file1</i> to <i>file2</i></p> <p>If <i>file2</i> is an existing directory, moves <i>file1</i> into directory <i>file2</i></p> <p>ln -s <i>file link</i> - create symbolic link <i>link</i> to <i>file</i></p> <p>touch <i>file</i> - create or update <i>file</i></p> <p>cat > <i>file</i> - places standard input into <i>file</i></p> <p>more <i>file</i> - output the contents of <i>file</i></p> <p>head <i>file</i> - output the first 10 lines of <i>file</i></p> <p>tail <i>file</i> - output the last 10 lines of <i>file</i></p> <p>tail -f <i>file</i> - output the contents of <i>file</i> as it grows, starting with the last 10 lines</p>	<p>date - show the current date and time</p> <p>cal - show this month's calendar</p> <p>uptime - show current uptime</p> <p>w - display who is online</p> <p>whoami - who you are logged in as</p> <p>finger <i>user</i> - display information about <i>user</i></p> <p>uname -a - show kernel information</p> <p>cat /proc/cpuinfo - cpu information</p> <p>cat /proc/meminfo - memory information</p> <p>man <i>command</i> - show the manual for <i>command</i></p> <p>df - show disk usage</p> <p>du - show directory space usage</p> <p>free - show memory and swap usage</p> <p>whereis <i>app</i> - show possible locations of <i>app</i></p> <p>which <i>app</i> - show which <i>app</i> will be run by default</p>
Process Management	Compression
<p>ps - display your currently active processes</p> <p>top - display all running processes</p> <p>kill <i>pid</i> - kill process id <i>pid</i></p> <p>killall <i>proc</i> - kill all processes named <i>proc</i> *</p> <p>bg - lists stopped or background jobs; resume a stopped job in the background</p> <p>fg - brings the most recent job to foreground</p> <p>fg <i>n</i> - brings job <i>n</i> to the foreground</p>	<p>tar cf <i>file.tar files</i> - create a tar named <i>file.tar</i> containing <i>files</i></p> <p>tar xf <i>file.tar</i> - extract the files from <i>file.tar</i></p> <p>tar czf <i>file.tar.gz files</i> - create a tar with Gzip compression</p> <p>tar xzf <i>file.tar.gz</i> - extract a tar using Gzip</p> <p>tar cjf <i>file.tar.bz2</i> - create a tar with Bzip2 compression</p> <p>tar xjf <i>file.tar.bz2</i> - extract a tar using Bzip2</p> <p>gzip <i>file</i> - compresses <i>file</i> and renames it to <i>file.gz</i></p> <p>gzip -d <i>file.gz</i> - decompresses <i>file.gz</i> back to <i>file</i></p>
File Permissions	Network
<p>chmod <i>octal file</i> - change the permissions of <i>file</i> to <i>octal</i>, which can be found separately for user, group, and world by adding:</p> <ul style="list-style-type: none"> 4 - read (r) 2 - write (w) 1 - execute (x) <p>Examples:</p> <p>chmod 777 - read, write, execute for all</p> <p>chmod 755 - rwx for owner, rx for group and world</p> <p>For more options, see man chmod.</p>	<p>ping <i>host</i> - ping <i>host</i> and output results</p> <p>whois <i>domain</i> - get whois information for <i>domain</i></p> <p>dig <i>domain</i> - get DNS information for <i>domain</i></p> <p>dig -x <i>host</i> - reverse lookup <i>host</i></p> <p>wget <i>file</i> - download <i>file</i></p> <p>wget -c <i>file</i> - continue a stopped download</p>
SSH	Installation
<p>ssh <i>user@host</i> - connect to <i>host</i> as <i>user</i></p> <p>ssh -p <i>port user@host</i> - connect to <i>host</i> on port <i>port</i> as <i>user</i></p> <p>ssh-copy-id <i>user@host</i> - add your key to <i>host</i> for <i>user</i> to enable a keyed or passwordless login</p>	<p>Install from source:</p> <p>./configure</p> <p>make</p> <p>make install</p> <p>dpkg -i <i>pkg.deb</i> - install a package (Debian)</p> <p>rpm -Uvh <i>pkg.rpm</i> - install a package (RPM)</p>
Searching	Shortcuts
<p>grep <i>pattern files</i> - search for <i>pattern</i> in <i>files</i></p> <p>grep -r <i>pattern dir</i> - search recursively for <i>pattern</i> in <i>dir</i></p> <p><i>command</i> grep <i>pattern</i> - search for <i>pattern</i> in the output of <i>command</i></p> <p>locate <i>file</i> - find all instances of <i>file</i></p>	<p>Ctrl+C - halts the current command</p> <p>Ctrl+Z - stops the current command, resume with fg in the foreground or bg in the background</p> <p>Ctrl+D - log out of current session, similar to exit</p> <p>Ctrl+W - erases one word in the current line</p> <p>Ctrl+U - erases the whole line</p> <p>Ctrl+R - type to bring up a recent command</p> <p>!! - repeats the last command</p> <p>exit - log out of current session</p>
<p>* use with extreme caution.</p>	



Terminal Commands

- Run (VM or <https://www.terminaltemple.com/>)
 - Exploring your current directory
 - Making and changing directories
 - Removing files and directories
- Run (VM or <https://sandbox.bio/tutorials/terminal-basics>)
 - Viewing and manipulating files
 - Searching files
 - Putting it all together

Location is Important



First Task – Where am I?

```
$ pwd
```

```
[genomics@genomics:~$ pwd  
/home/genomics  
genomics@genomics:~$
```

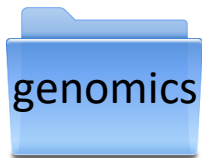
This is your “present working directory”.

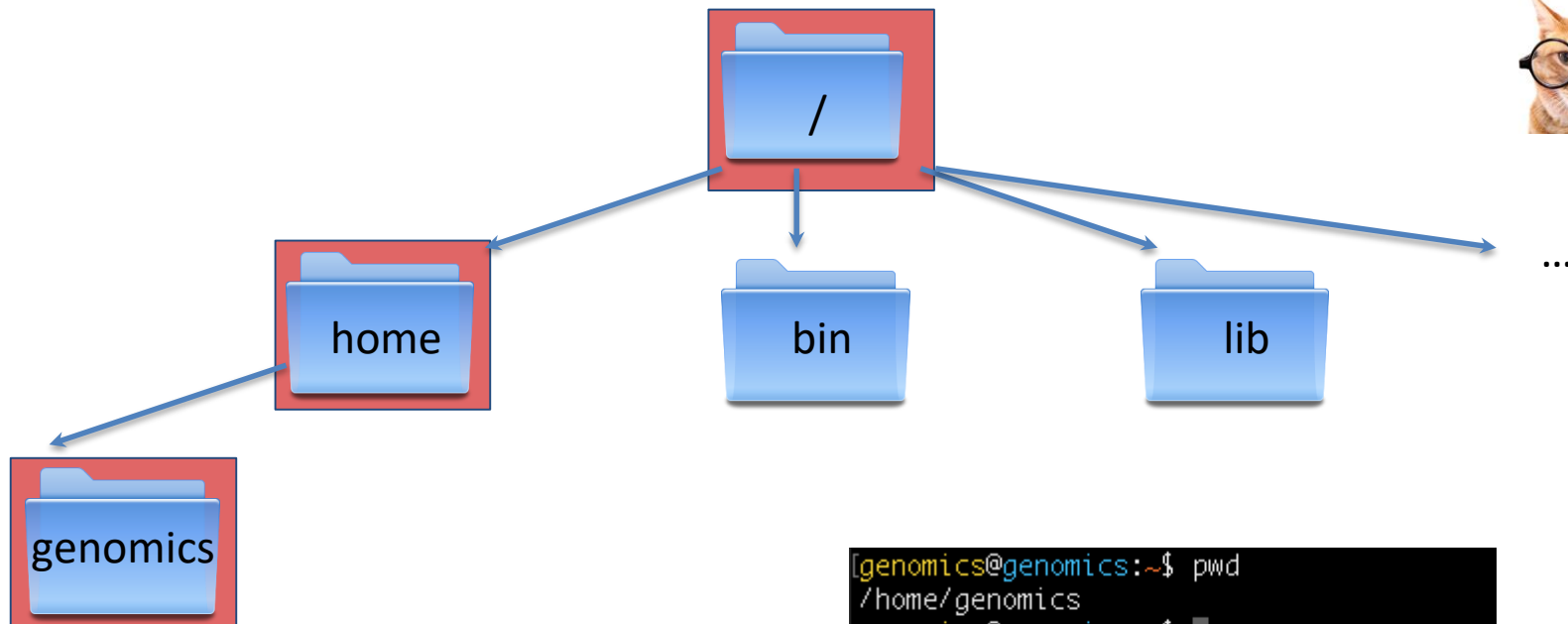


= ROOT

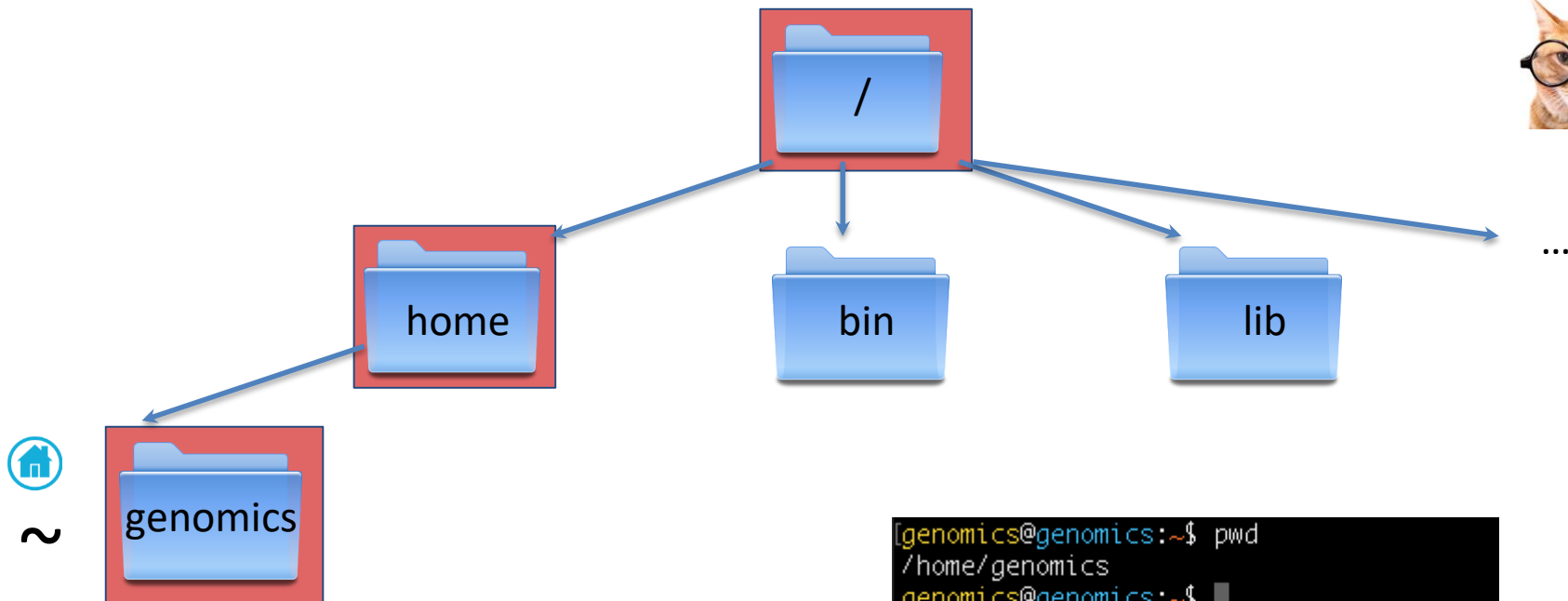


...





```
genomics@genomics:~$ pwd  
/home/genomics  
genomics@genomics:~$ █
```

```
genomics@genomics:~$ pwd
/home/genomics
genomics@genomics:~$ █
```

This location is also known as your
Home Directory

Tilde is shorthand for Home ~

Now let's create some directories and files



Make a directory

```
$ mkdir Data
```

Change into this directory

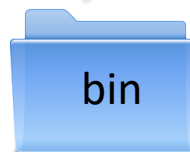
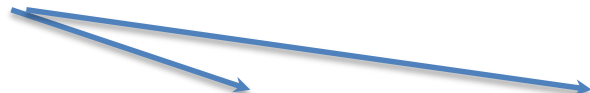
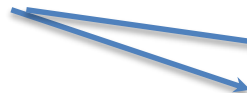
```
$ cd Data
```

Now what is your present working directory?

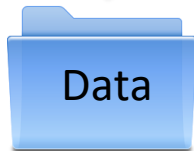
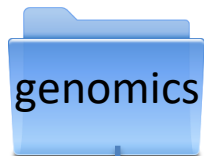
NOTE! Directory names (and file names for the matter) can not contain spaces. Underscores are often used instead if you want to separate words.

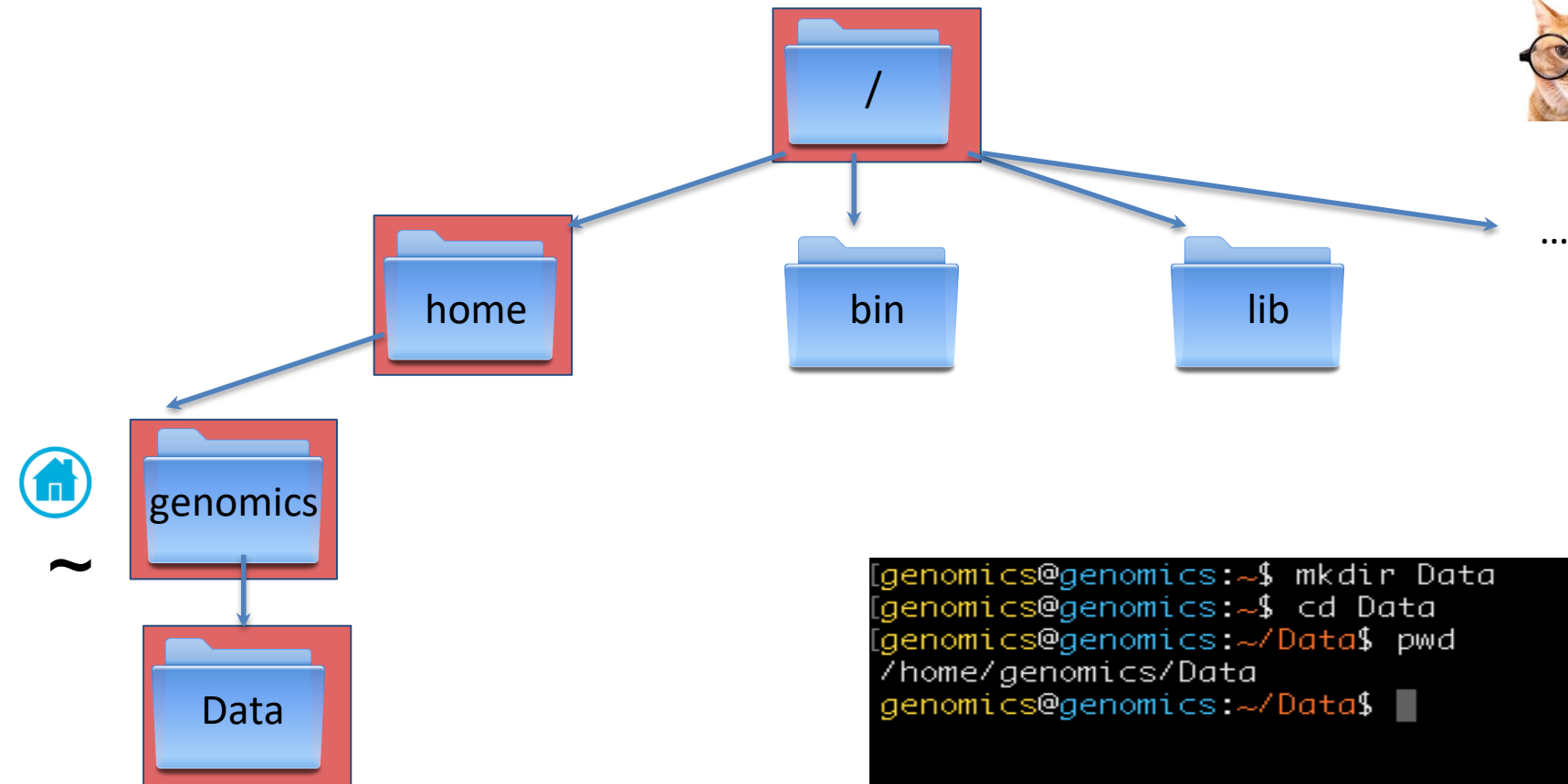


...



~





```
[genomics@genomics:~$ mkdir Data  
[genomics@genomics:~$ cd Data  
[genomics@genomics:~/Data$ pwd  
/home/genomics/Data  
genomics@genomics:~/Data$
```

Now let's create some directories and files



Make an empty file

```
$ touch rags
```

And another two

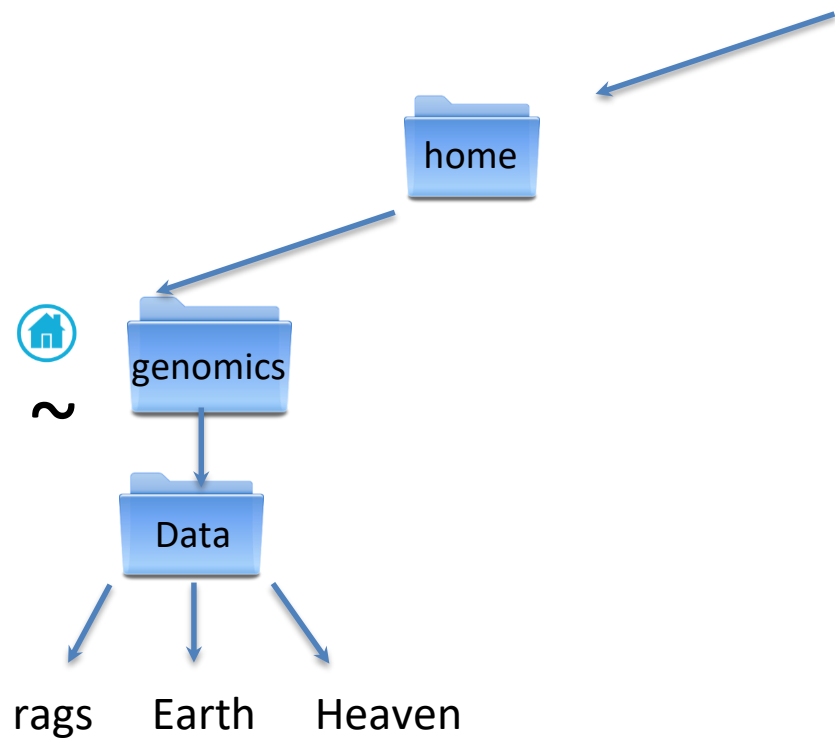
```
$ touch Earth
```

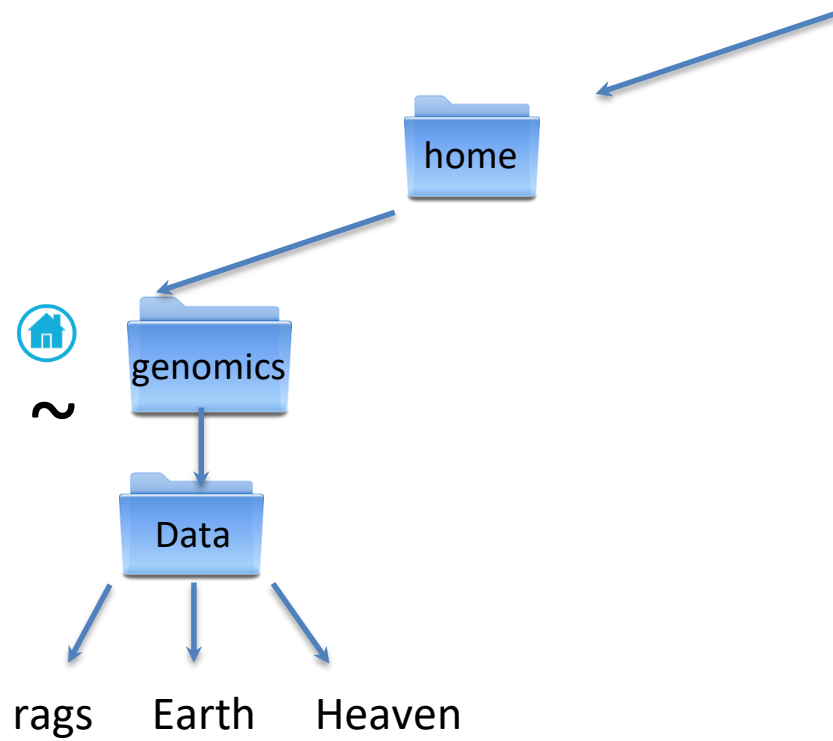
```
$ touch Heaven
```

Now let's list the contents of the current directory (Data)

```
$ ls
```

```
genomics@genomics:~/Data$ touch rags
genomics@genomics:~/Data$ touch Earth Heaven
genomics@genomics:~/Data$ ls
Earth Heaven rags
genomics@genomics:~/Data$
```

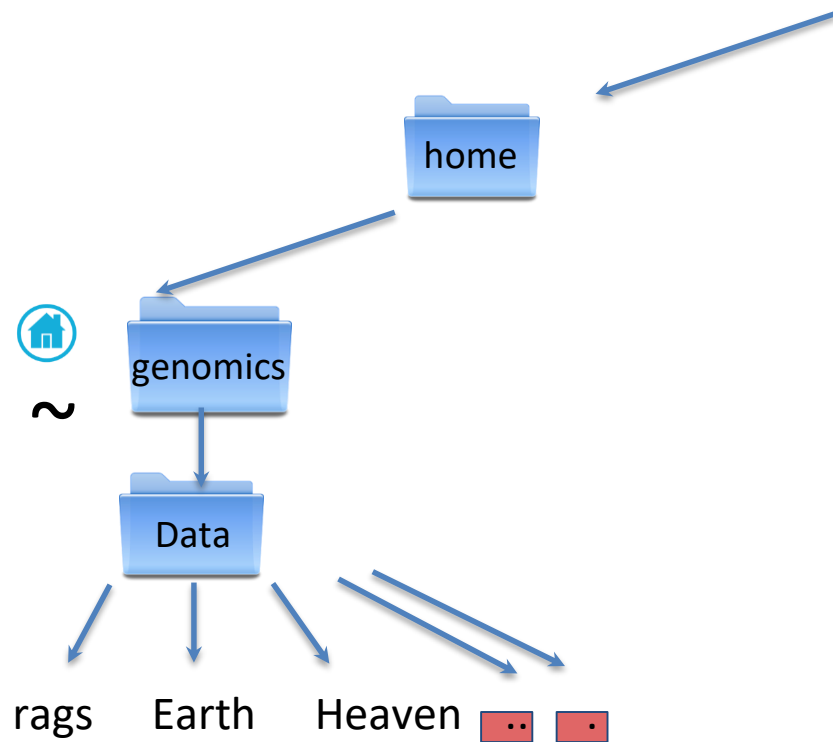




Now list ALL of the files

```
$ ls -a
```

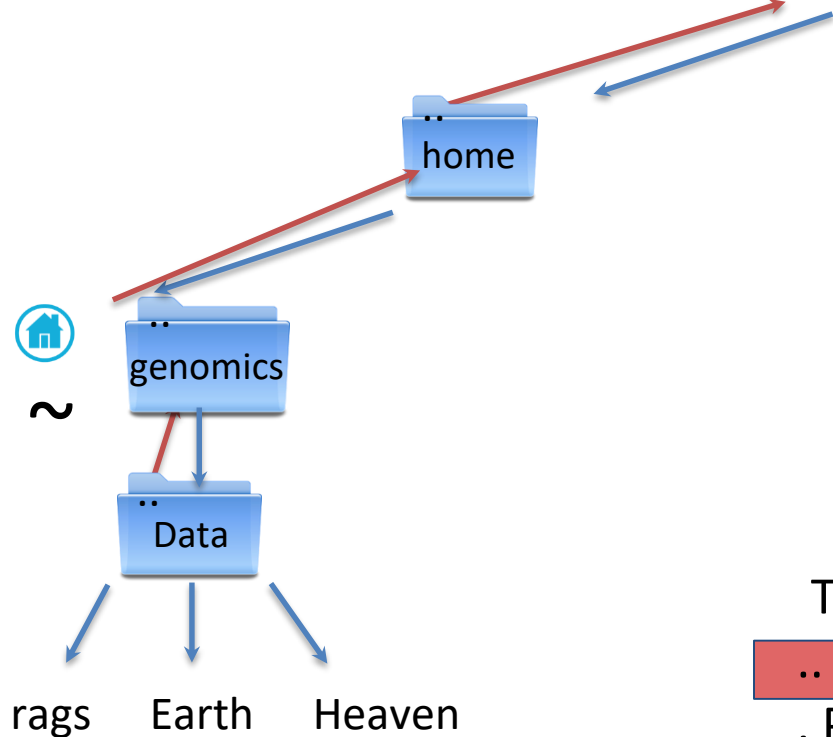
```
genomics@genomics:~/Data$ ls -a
.  ..  Earth  Heaven  rags
genomics@genomics:~/Data$
```



Now list ALL of the files

```
$ ls -a
```

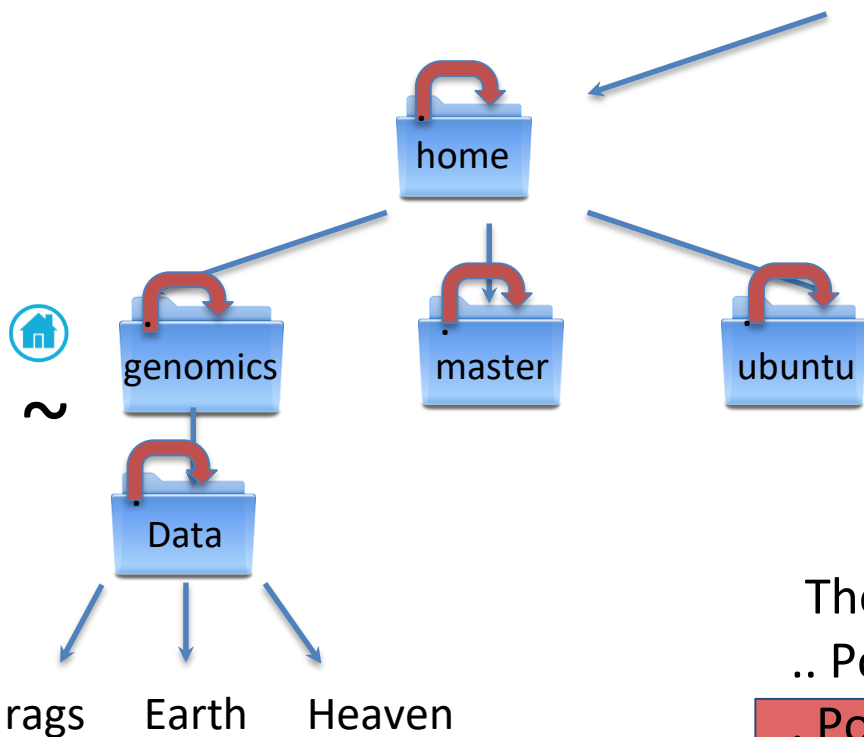
```
[genomics@genomics:~/Data$ ls -a
.  ..  Earth  Heaven  rags
genomics@genomics:~/Data$
```

These special files are in every directory

.. Points to one directory above

. Points to the current directory



These special files are in every directory

- .. Points to one directory above
- . Points to the current directory

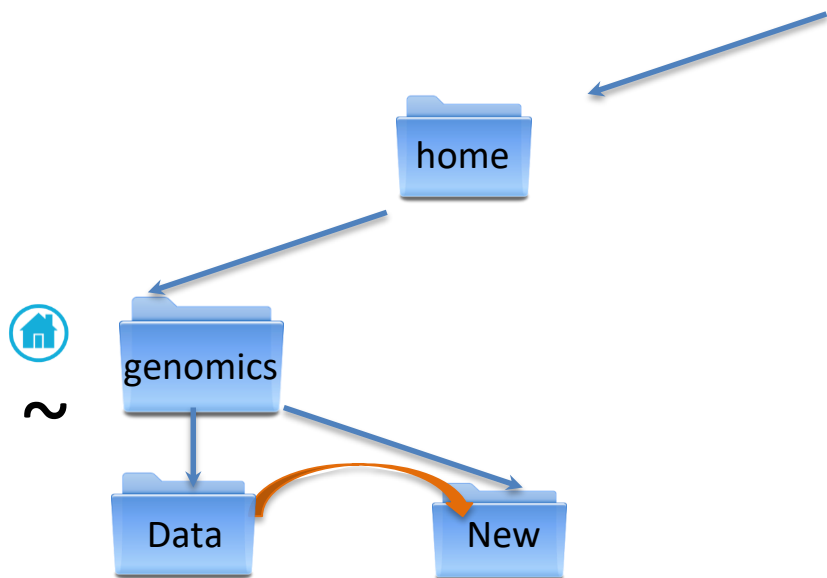


. and .. are used for specifying location

Whenever you do anything on Linux
(move around, move a file, rename a file etc...)
You have to tell the system where that thing is
using a path

. and .. are part of RELATIVE paths

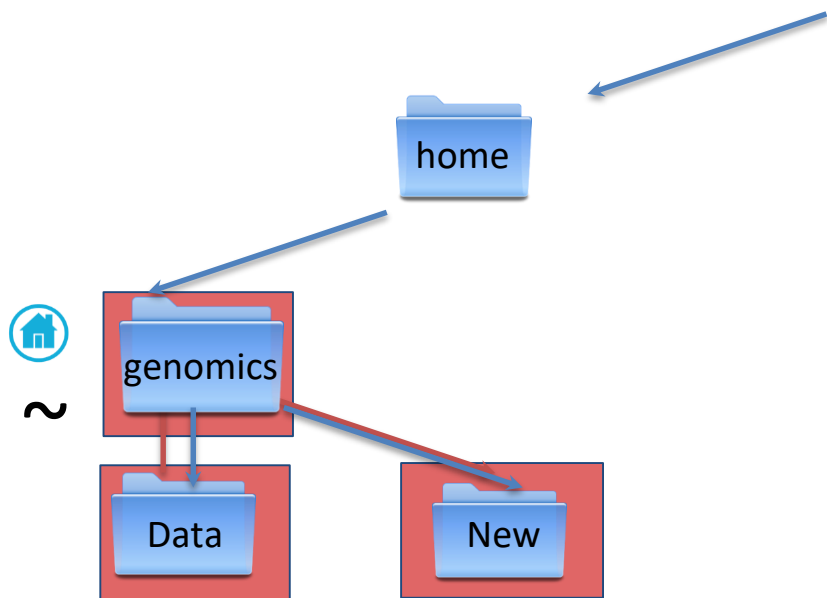




Moving from Data to New

RELATIVE PATH

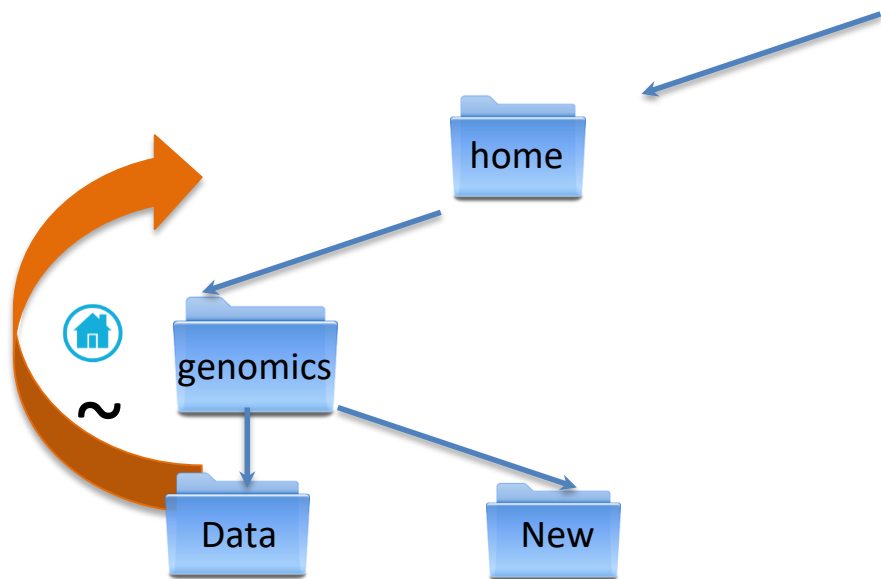
```
$ cd ../New
```



Moving from Data to New

RELATIVE PATH

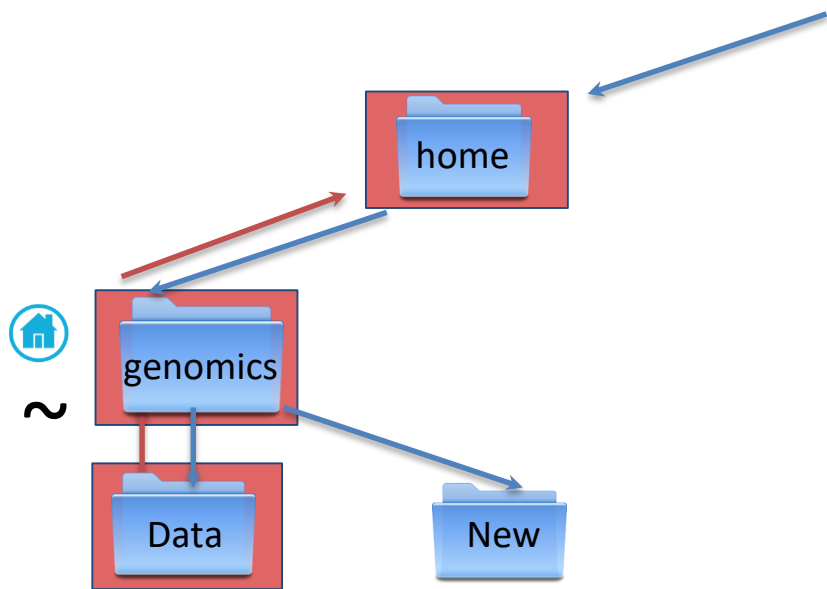
```
$ cd ../New
```



Moving from Data to home

RELATIVE PATH

```
$ cd ../.. /
```



Moving from Data to home

RELATIVE PATH

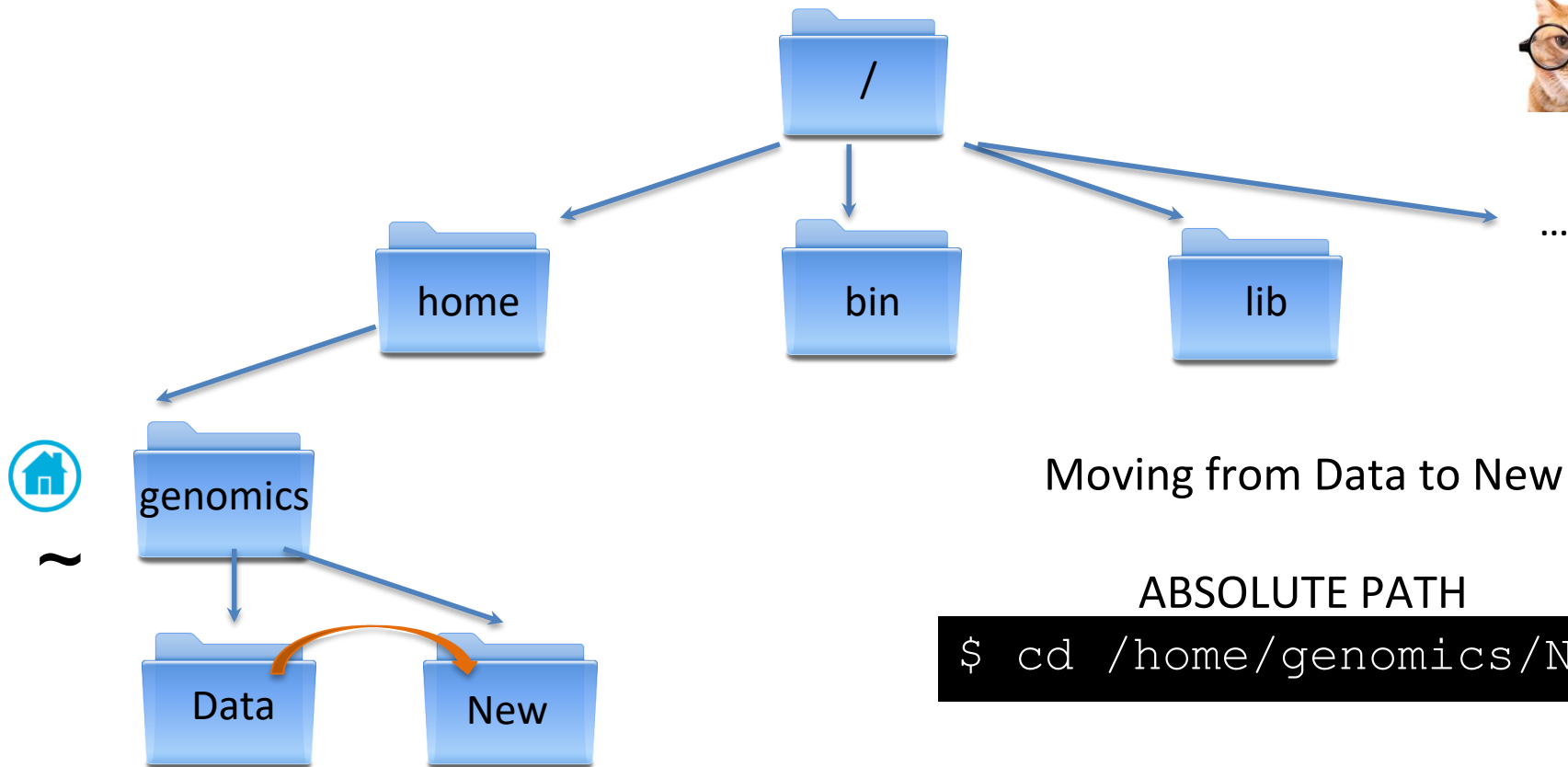
```
$ cd ../.. /
```



Relative paths will always change depending on your location.

The alternative is ABSOLUTE paths. These always start from root and will never change.

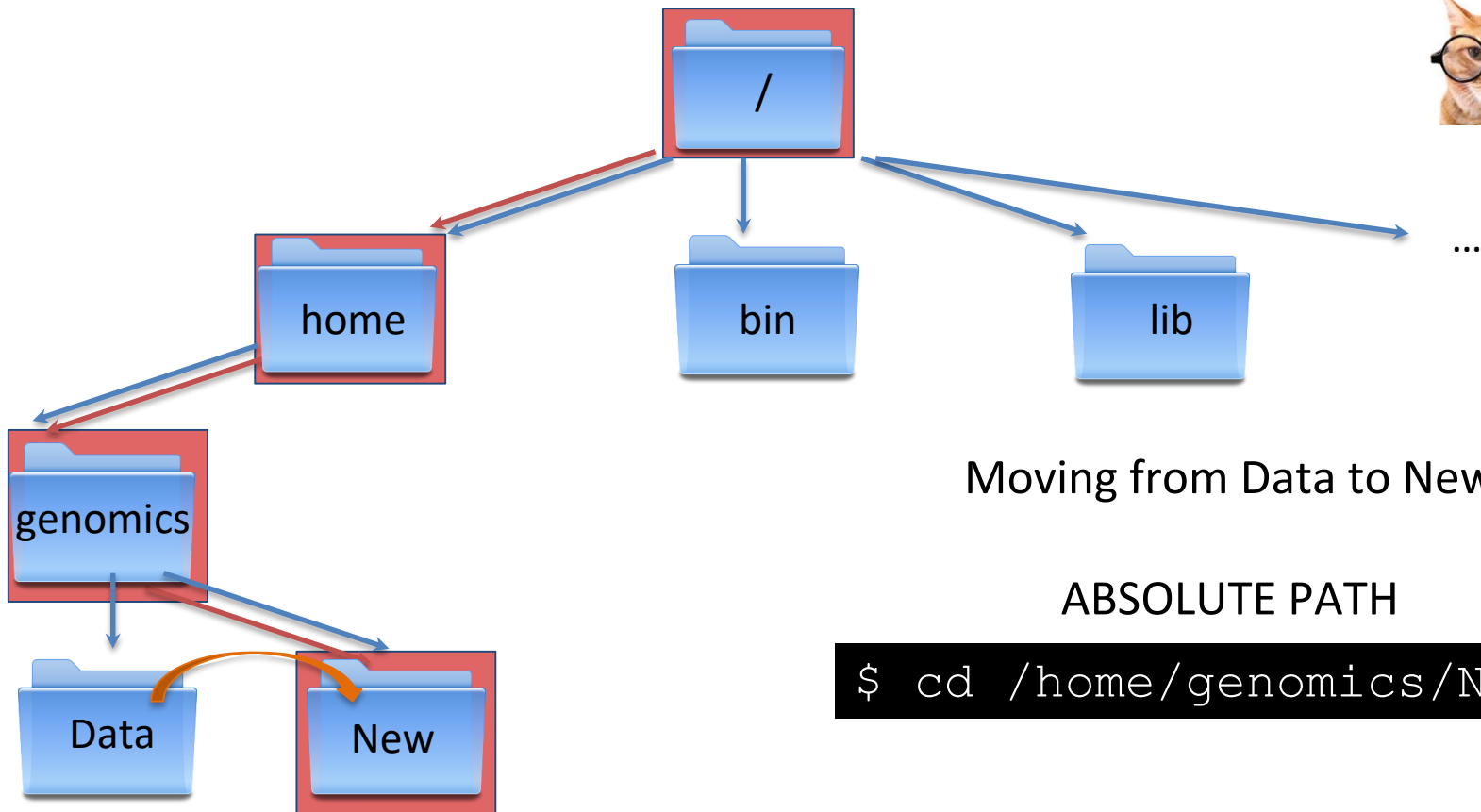




Moving from Data to New

ABSOLUTE PATH

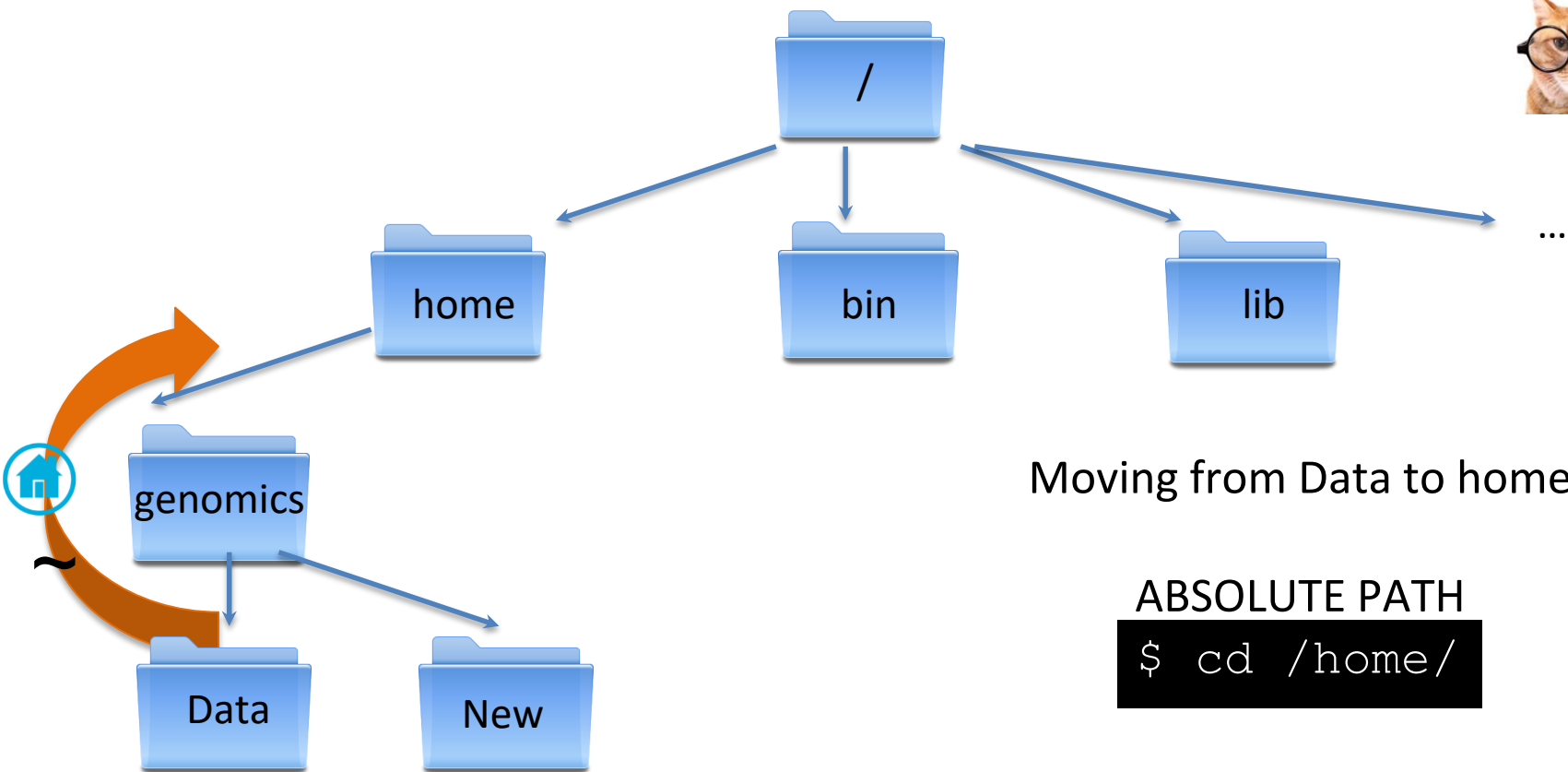
```
$ cd /home/genomics/New
```

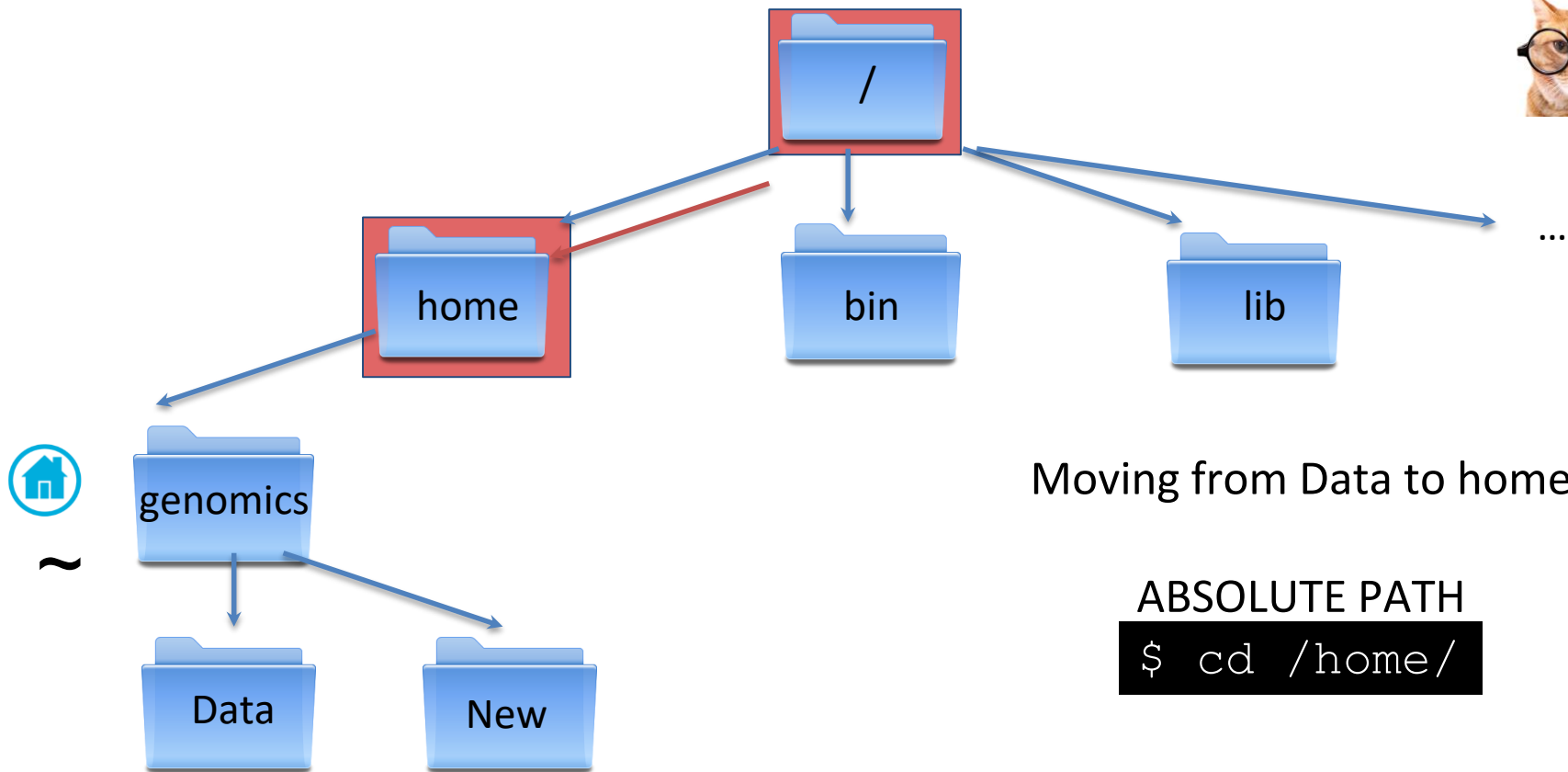


Moving from Data to New

ABSOLUTE PATH

```
$ cd /home/genomics/New
```





Let's put this to practice



Where am I right now? (Should be the Data directory)

```
$ pwd
```

Change to the directory above

```
$ cd ../
```

Let's list the contents of the Data directory

```
$ ls ./Data/
```

CHALLENGE 1!

1. Move into the Data directory and list the contents of your home directory
2. In Data, make a new directory and move into this location
3. From this new directory, move into your own home directory (genomics)
IN ONE COMMAND and check your location

Challenge 1!



1. Move into the Data directory and list the contents of your Home directory

```
$ cd Data
```

```
$ ls ..
```

 OR

```
$ ls /home/genomics/
```

 OR

```
$ ls ~
```

2. In Data, make a new directory and move into this location

```
$ mkdir new
```

```
$ cd new
```

3. From this new directory, move into your Home directory IN ONE COMMAND and check your location

```
$ cd ../../
```

 OR

```
$ cd /home/genomics/
```

 OR

```
$ cd ~
```

 OR

```
$ cd
```

```
$ pwd
```

Any Questions So Far?



Wait a little !

Every binary program has a manual



To view the manual page, type `man` followed by the name of the program

```
$ man <PROGRAMME>
```

Open the manual page for `ls`

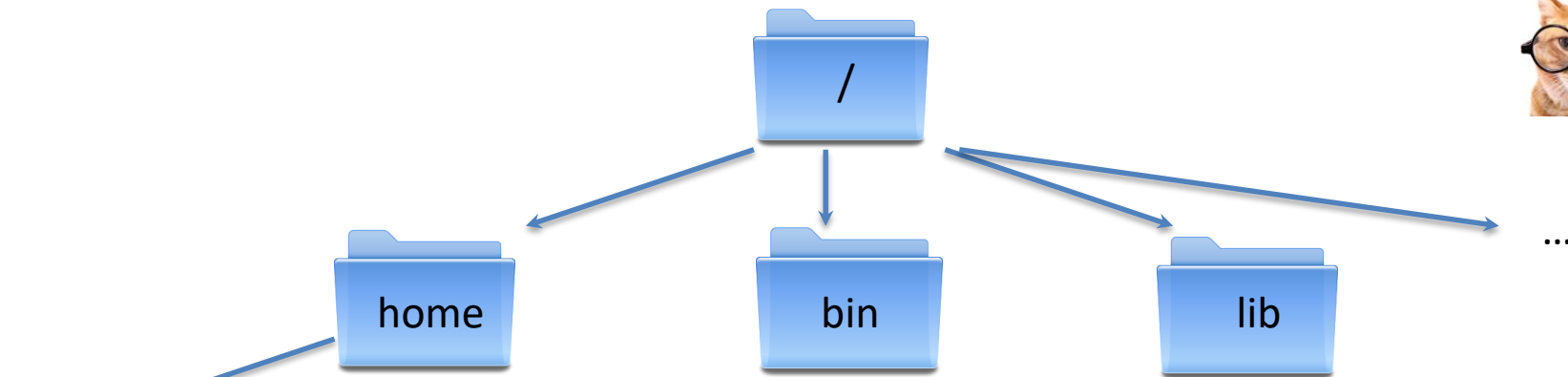
```
$ man ls
```

Scroll through (enter) and find the options for:

long listing format (**-l**), human-readable sizes (**-h**) and sort by modification time (**-t**)

Exit the manual page (type `q`)

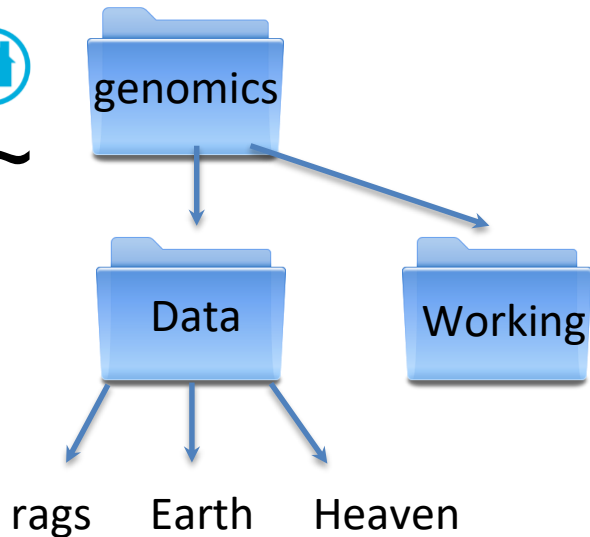
A blue book with the words "USER MANUAL" in white capital letters. The book is shown at an angle, revealing its white pages.

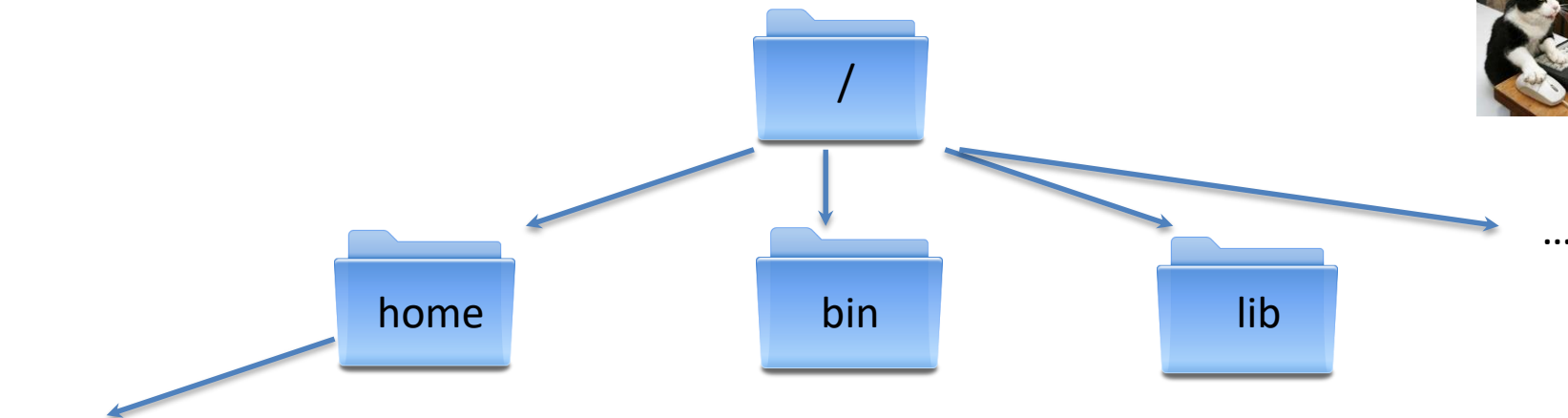


Examples!

First I need you to make a new directory called “Working” within your home directory.

Afterwards your file structure should look like this!





Moving Files

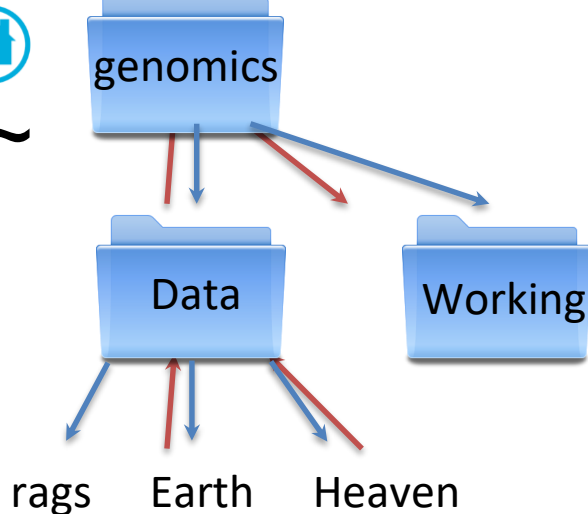
Lets move Heaven and Earth from Data to Working

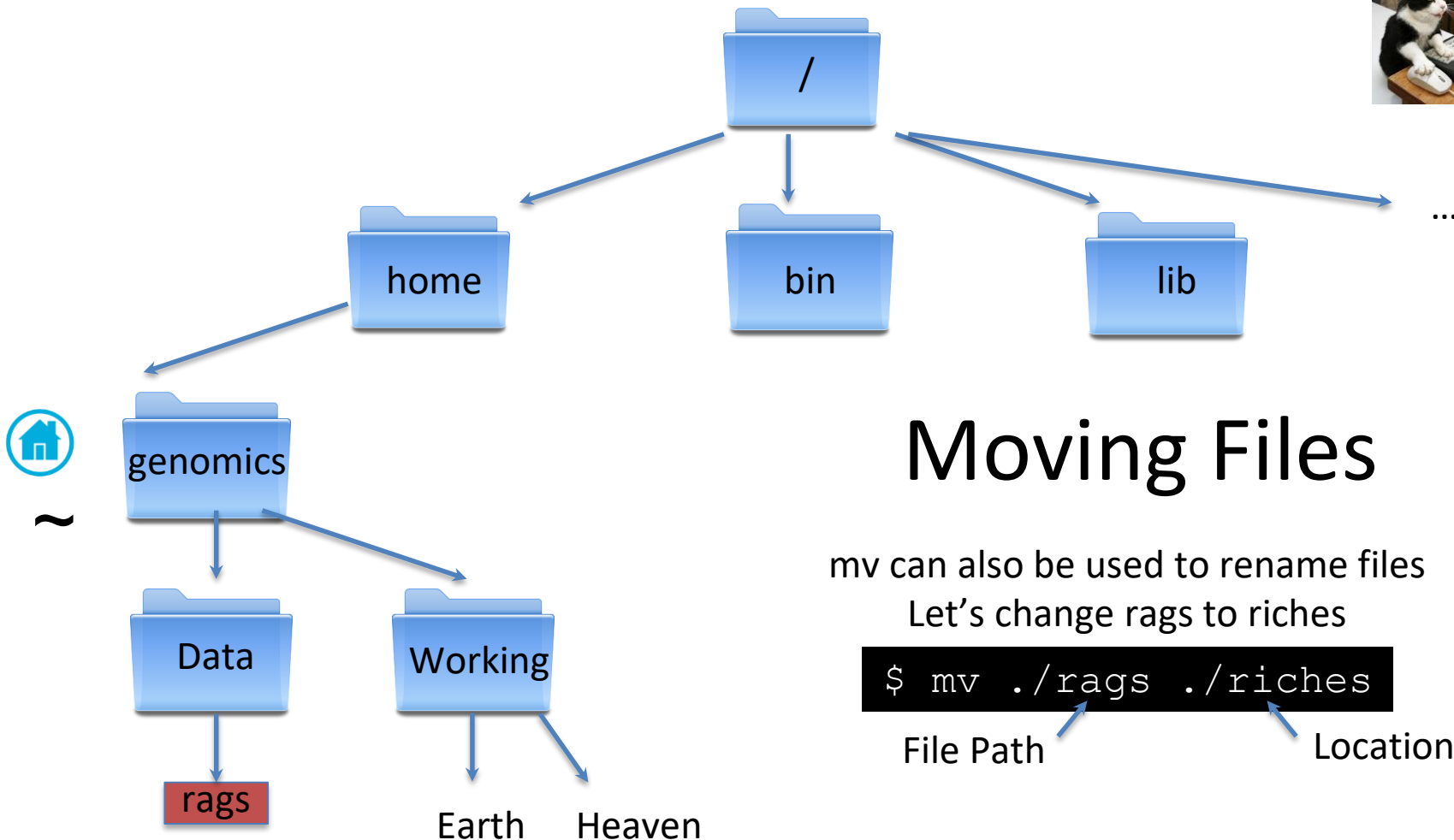
```
$ cd ~/Data  
$ mv ./Earth ../Working/
```

File Path

Location Path

Now move Heaven too





Moving Files

mv can also be used to rename files

Let's change rags to riches

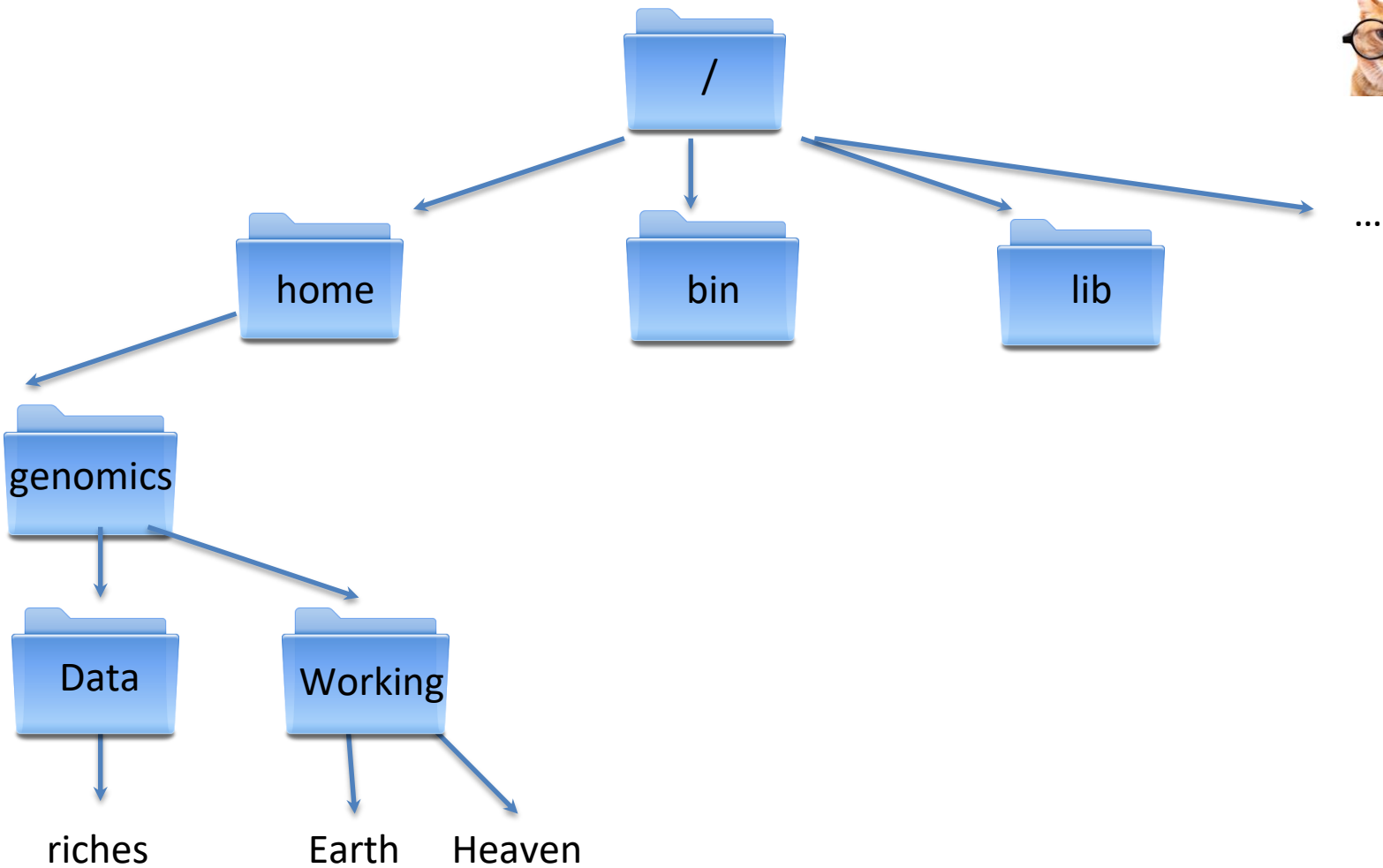
```
$ mv ./rags ./riches
```

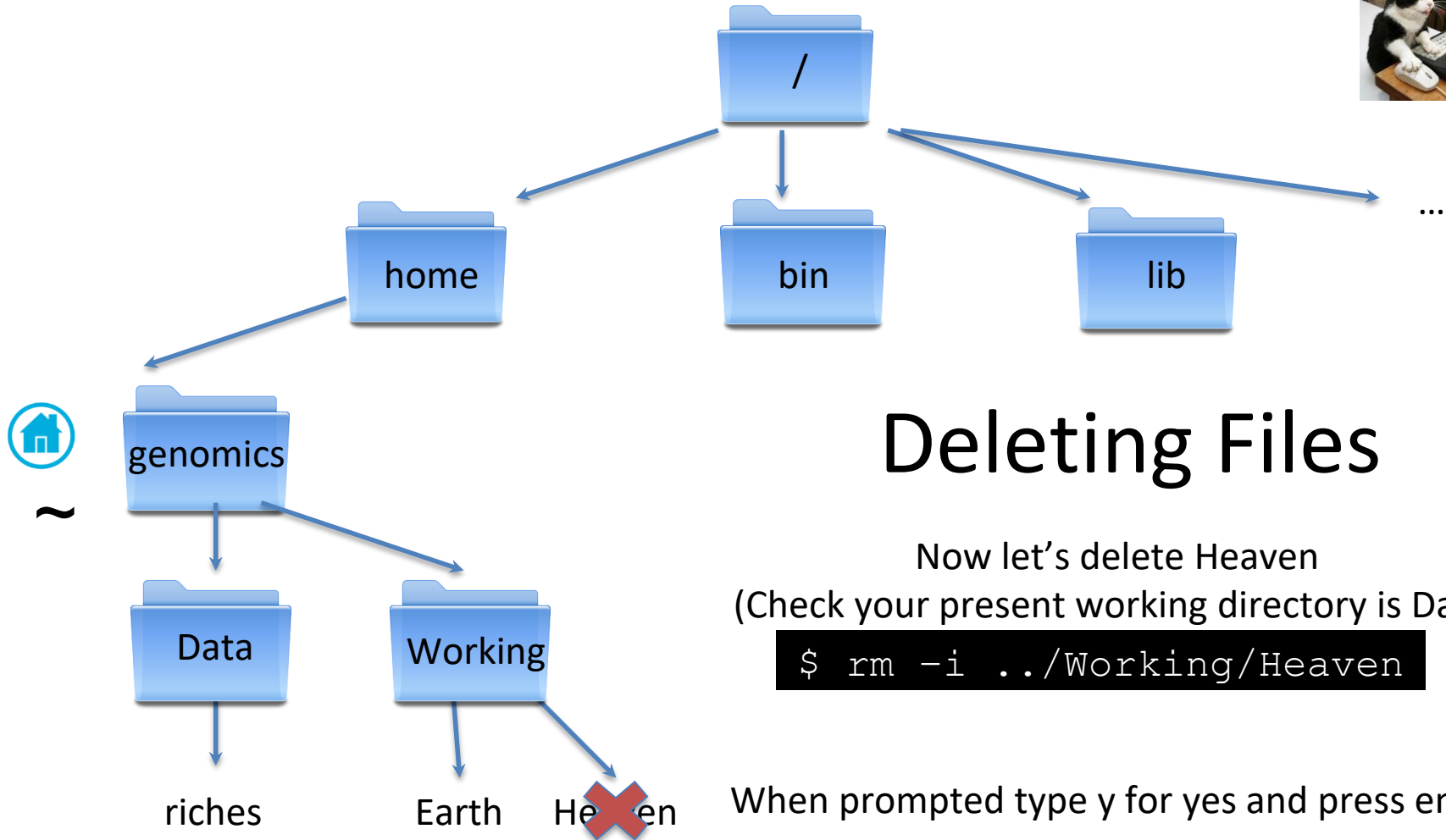
File Path

Location Path



~





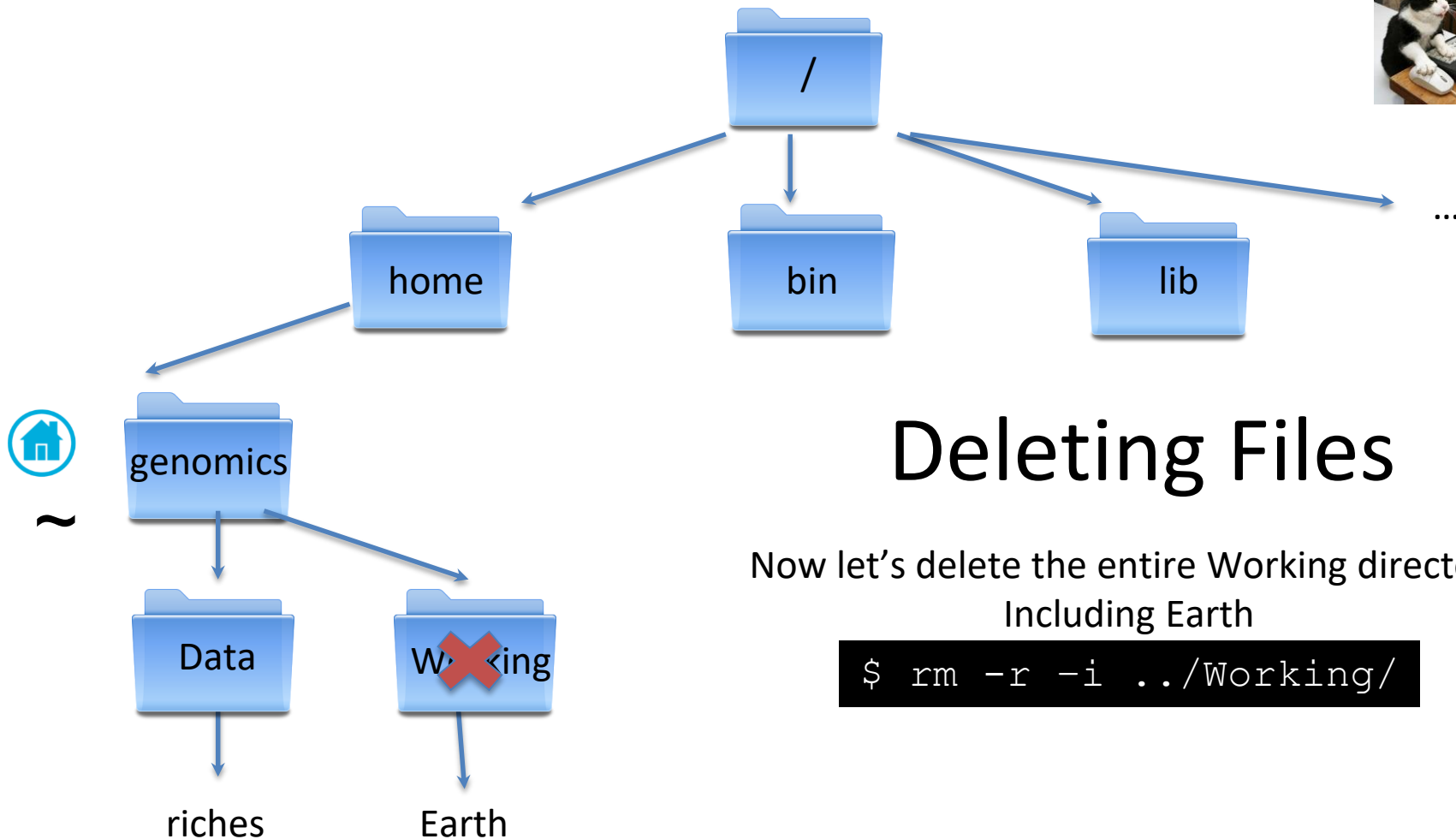
Deleting Files

Now let's delete Heaven

(Check your present working directory is Data)

```
$ rm -i ../Working/Heaven
```

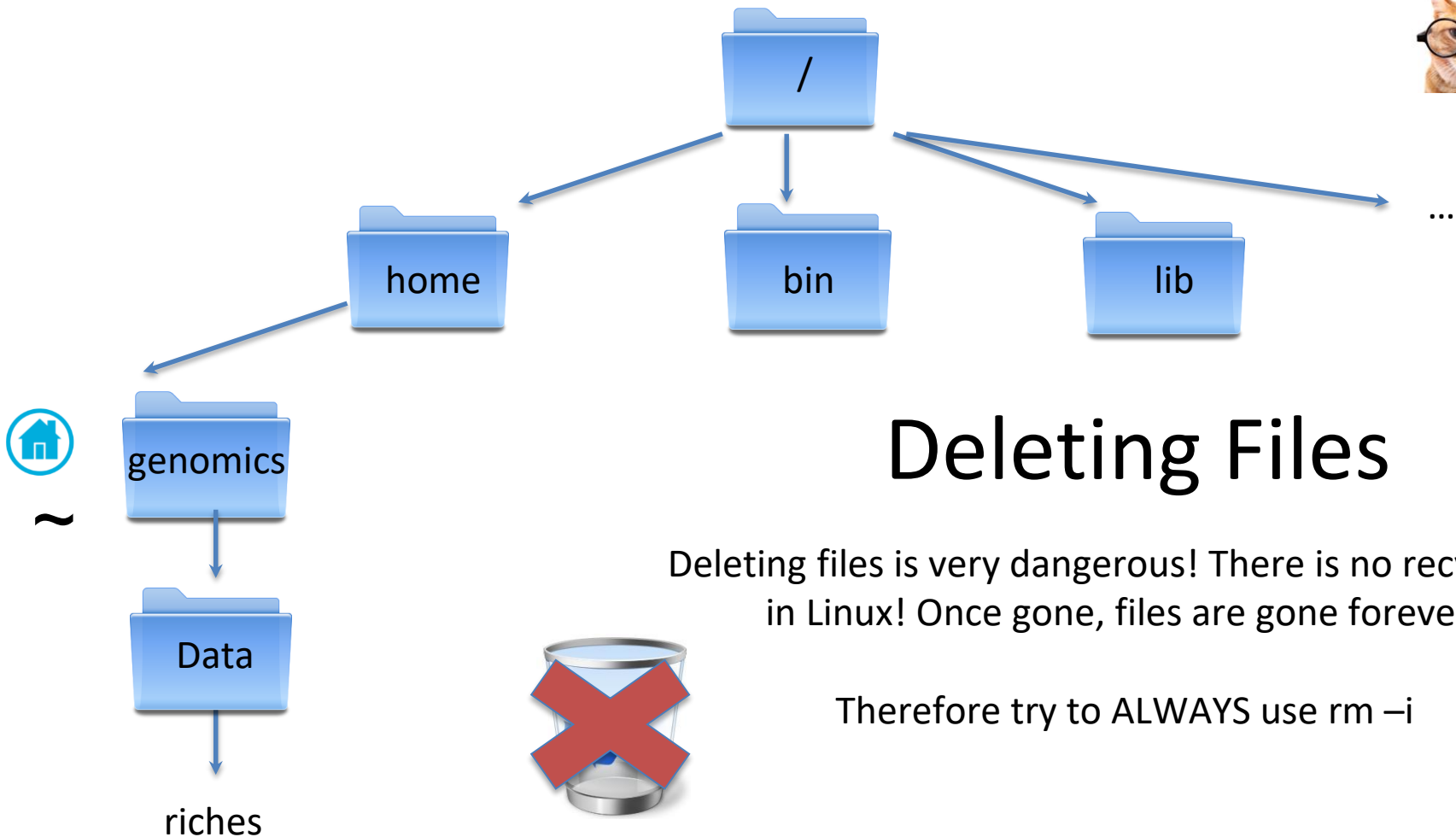
When prompted type y for yes and press enter



Deleting Files

Now let's delete the entire Working directory
Including Earth

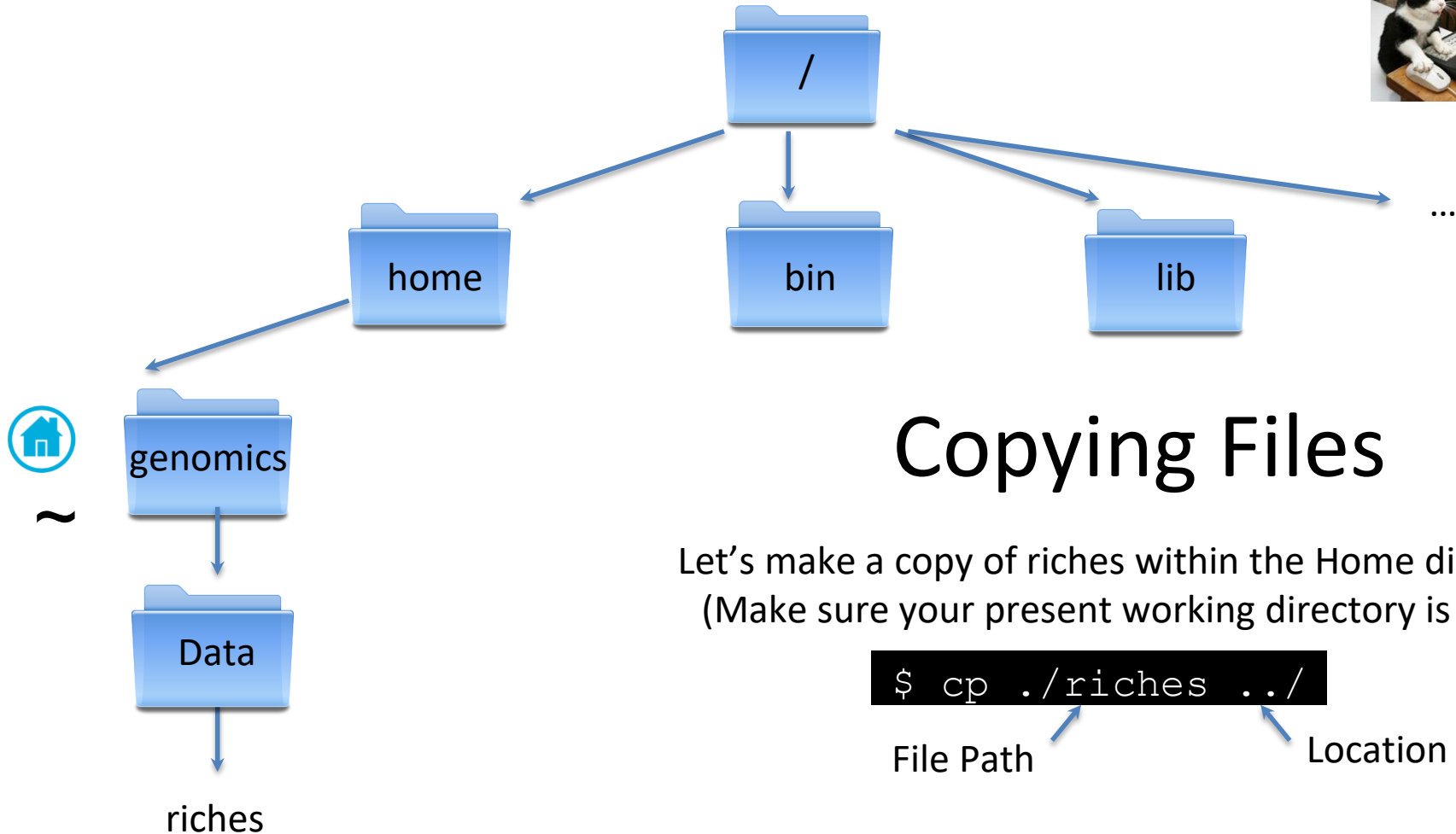
```
$ rm -r -i ../Working/
```



Deleting Files

Deleting files is very dangerous! There is no recycle bin in Linux! Once gone, files are gone forever!

Therefore try to ALWAYS use `rm -i`



Copying Files

Let's make a copy of riches within the Home directory
(Make sure your present working directory is Data)

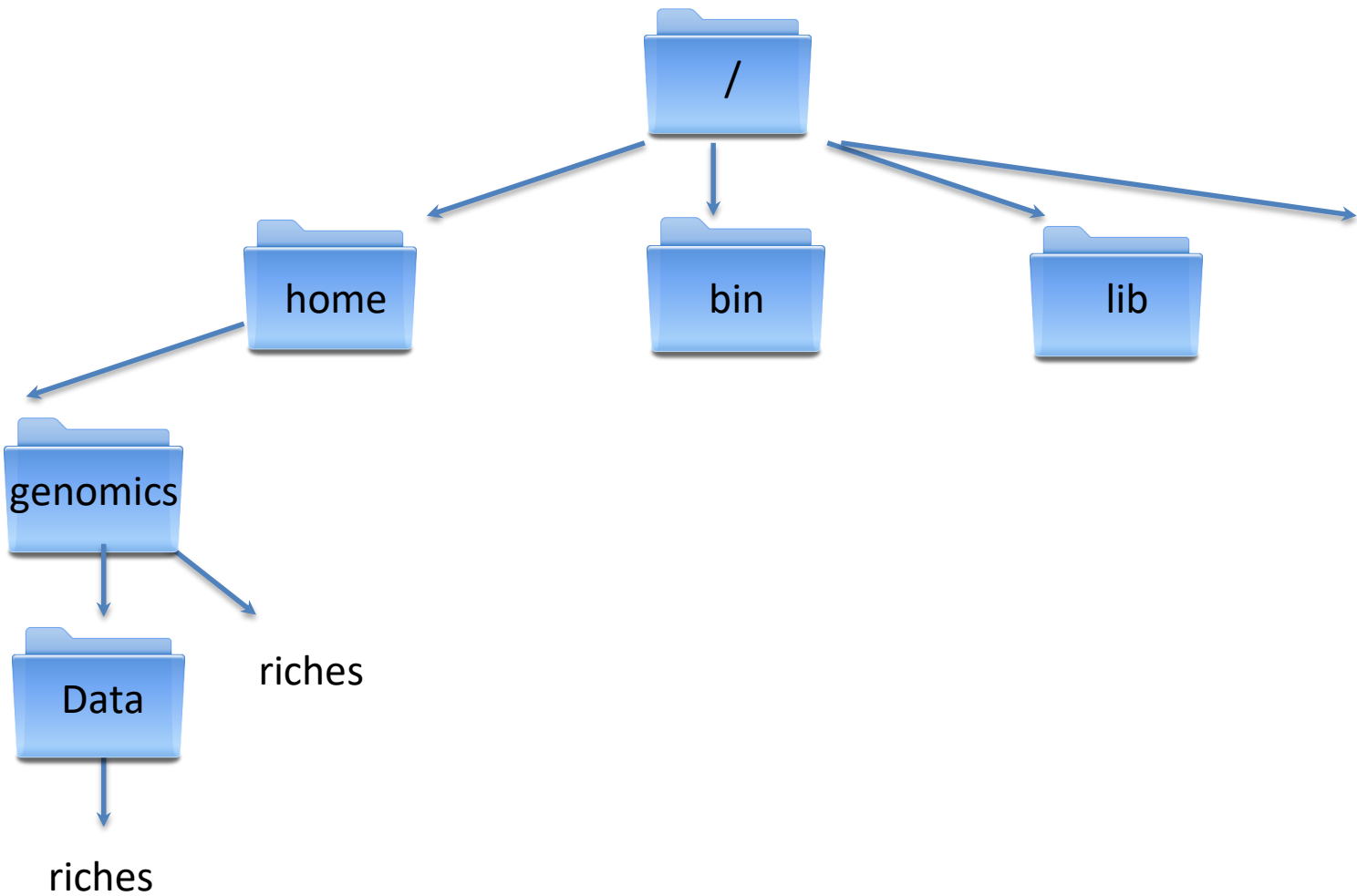
```
$ cp ./riches ../
```

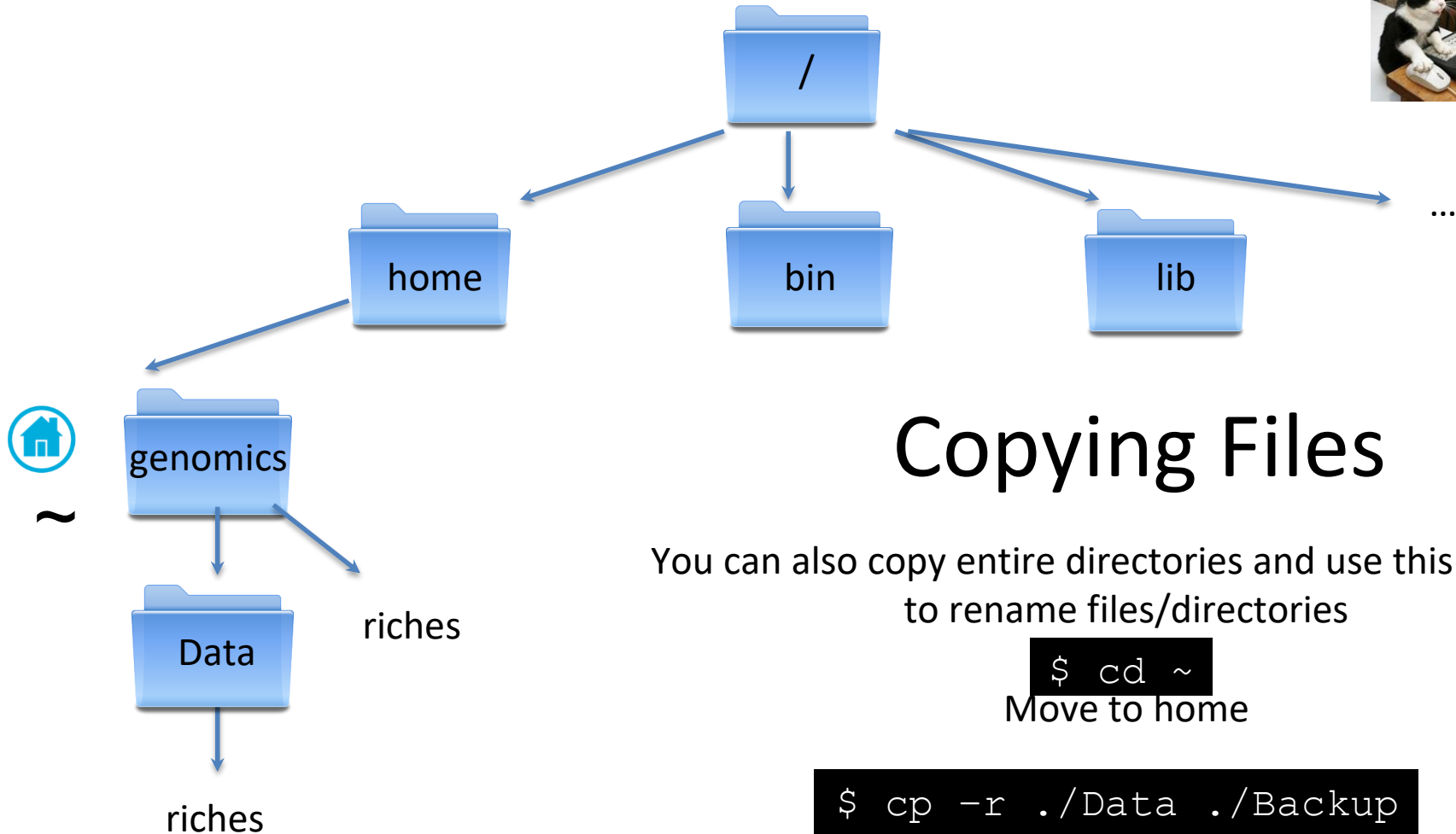
File Path

Location Path



~





Copying Files

You can also copy entire directories and use this function to rename files/directories

```
$ cd ~
```

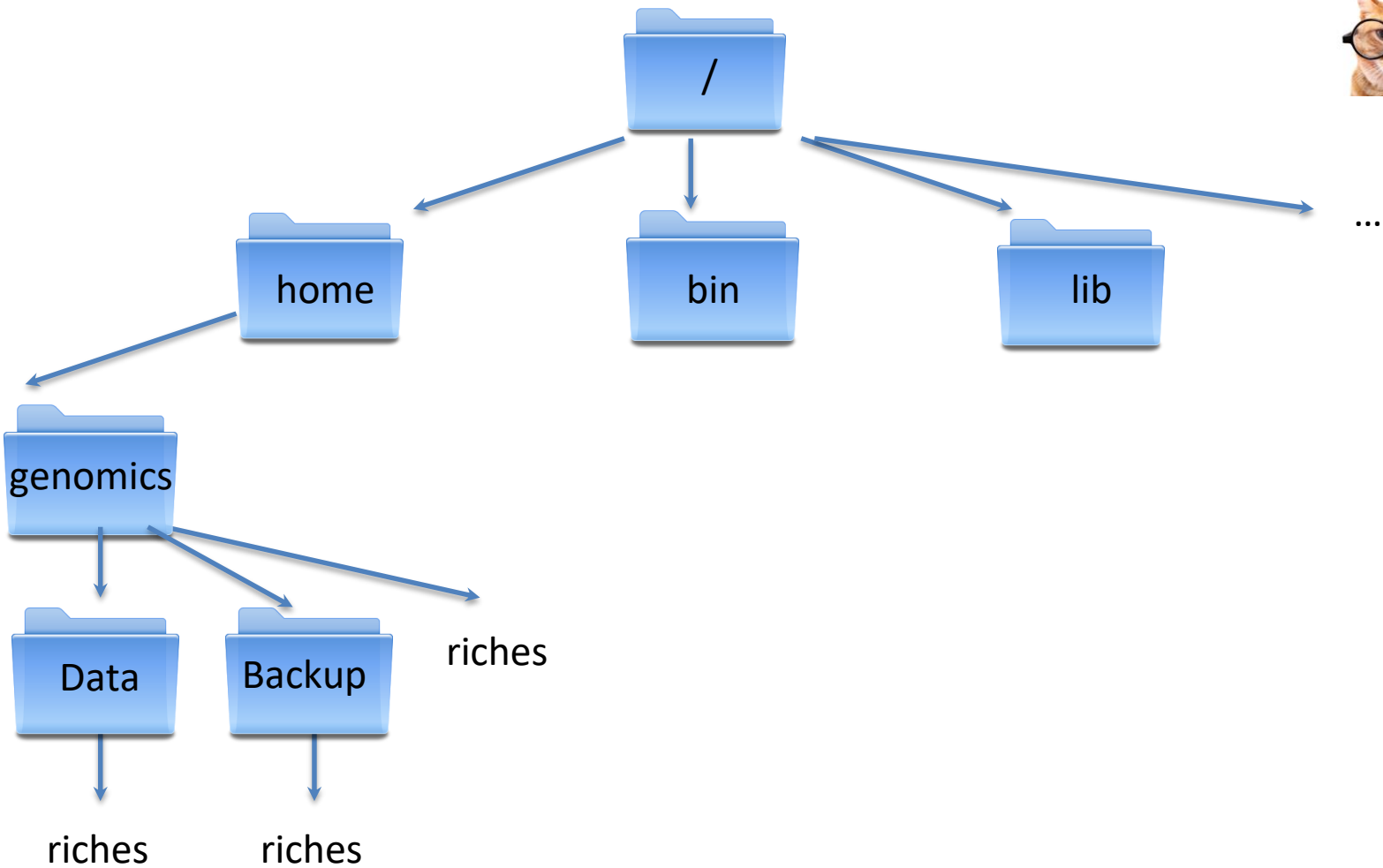
Move to home

```
$ cp -r ./Data ./Backup
```

Make a copy of the Data directory here and call it Backup



~



Any Questions So Far?



The End of the second session

File Commands

ls - directory listing
ls -al - formatted listing with hidden files
cd *dir* - change directory to *dir*
cd - change to home
pwd - show current directory
mkdir *dir* - create a directory *dir*
rm *file* - delete *file*
rm -r *dir* - delete directory *dir*
rm -f *file* - force remove *file*
rm -rf *dir* - force remove directory *dir* *
cp *file1 file2* - copy *file1* to *file2*
cp -r *dir1 dir2* - copy *dir1* to *dir2*; create *dir2* if it doesn't exist
mv *file1 file2* - rename or move *file1* to *file2*
if *file2* is an existing directory, moves *file1* into directory *file2*
ln -s *file link* - create symbolic link *link* to *file*
touch *file* - create or update *file*
cat > *file* - places standard input into *file*
more *file* - output the contents of *file*
head *file* - output the first 10 lines of *file*
tail *file* - output the last 10 lines of *file*
tail -f *file* - output the contents of *file* as it grows, starting with the last 10 lines

Terminal Commands

- Run (VM or <https://www.terminaltemple.com/>)
 - Exploring your current directory
 - Making and changing directories
 - Removing files and directories
- Run (VM or <https://sandbox.bio/tutorials/terminal-basics>)
 - Viewing and manipulating files
 - Searching files
 - Putting it all together

Think of them as Unix versions of Notepad.

Some have an interactive user interface – E.G. gedit

Some work from within the command line – E.G. nano, vim, emacs



Key Nano Commands



Ctrl + O – This saves the file. You will be asked for a file name. Type the name and press enter.



Ctrl + X – This exits nano. If the file is unsaved, you will be asked at this point if you'd like to save it.



How Do You Install Software?



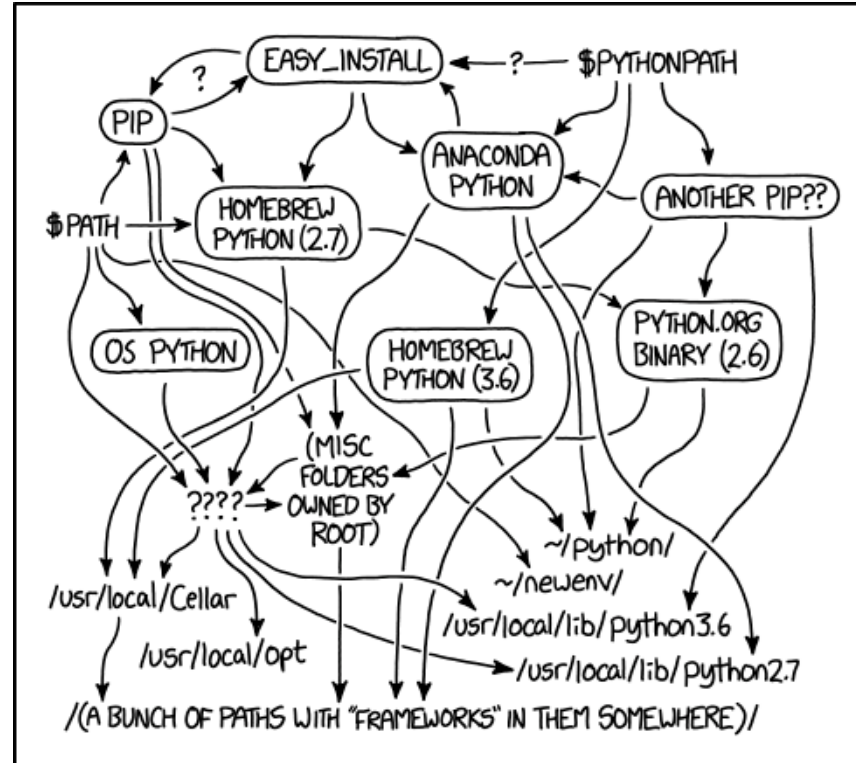
Some binary programs come with Ubuntu e.g. mkdir, ls etc...

However most software for bioinformatics needs to be installed.

when you begin working on a system you may need to do this.

If you're using a shared compute resource, you'll likely need to ask your system administrator to do this.

IT IS NOT AS EASY AS IT SOUNDS



Software Installation



The “get and compile” method!

Get the software from somewhere and then install it manually.



GitHub is a fantastic repository containing a lot of bioinformatics software! It works using git so it's easy to download.

Challenge 2!



I want you to download and compile the software unicycler.

Here is the github page - <https://github.com/rrwick/Unicycler>

Make sure you are in your home directory.

Follow the instructions under “Build and run without installation”.

Take a read/glance of all of the information under “Requirements” and “Installation” – I just want you to read here!

What Have We Just Done?



```
git clone https://github.com/rrwick/Unicycler.git
```

This has downloaded the software from github

```
cd Unicycler
```

This has changed the location to this new directory

```
make
```

This has COMPILED the software

But what happens if you type unicycler on the command line now?

```
genomics@genomics:~$ unicycler
unicycler: command not found
genomics@genomics:~$
```

Why!? Compiling \neq Installing!



Installation

For software to be truly installed, it needs to be added to the directory
/usr/bin or /usr/local/bin

And this requires admin privileges which you don't have!

However you can still run the newly compiled software directly by using the path:

```
genomics@genomics:~/Unicycler$ ./unicycler-runner.py
usage: unicycler-runner.py [-h] [--help_all] [--version] [-1 SHORT1] [-2 SHORT2] [-s UNPAIRED] [-l LONG] -o OUT
                        [--verbosity VERBOSITY] [--min_fasta_length MIN_FASTA_LENGTH] [--keep KEEP] [-t THREADS]
                        [--mode {conservative,normal,bold}] [--linear_seqs LINEAR_SEQS] [--vcf]
```



Unicycler: an assembly pipeline for bacterial genomes

However! It still won't work...



What! I hear you cry! Why!?

Requirements

- Linux or macOS
- [Python](#) 3.4 or later
- C++ compiler with C++14 support:
 - [GCC](#) 4.9.1 or later
 - [Clang](#) 3.5 or later
 - [ICC](#) also works (though I don't know the minimum required version number)
- [setuptools](#) (only required for installation of Unicycler)
- For short-read or hybrid assembly:
 - [SPAdes](#) v3.6.2 or later (`spades.py`)
- For long-read or hybrid assembly:
 - [Racon](#) (`racon`)
- For polishing
 - [Pilon](#) (`pilon1.xx.jar`)
 - [Java](#) (`java`)
 - [Bowtie2](#) (`bowtie2-build` and `bowtie2`)
 - [Samtools](#) v1.0 or later (`samtools`)
- For rotating circular contigs:
 - [BLAST+](#) (`makeblastdb` and `tblastn`)

Dependencies



A lot of software needs other software to work...
Which in turn needs other software..
Which also needs other software...

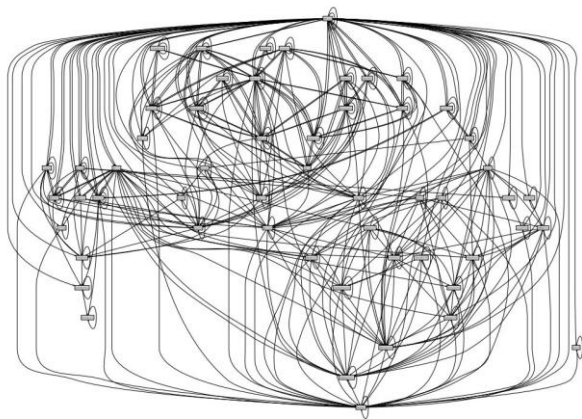


Figure 1.5.: The *dependency hell*: the runtime dependency graph of Mozilla Firefox

Software Managers



```
apt install
```

Synaptic



```
pip install
```

Important Initial Commands

1. `sudo apt update`
2. `sudo apt install synaptic`
3. `sudo apt install pip`

Confused!?
Don't worry, you
aren't the only one!



This section is just to make you aware of software installation techniques so you aren't surprised when you get home and can't find SAMtools on your system!